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MILITARY OCCUPATIONAL ANALYSIS: ISSUES AND ADVANCES IN RESEARCH AND APPLICATION

ARMSTRONG LABORATORY

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Historically, some of the most significant research and development (R&D) in occupational analysis (OA) has been accomplished by military organizations for military applications. Several of the most important OA methodologies were developed under military sponsorship. Examples include functional job analysis, worker-oriented approaches (the Position Analysis Questionnaire, the General Work Inventory, etc.), and the Task Inventory/Comprehensive Occupational Data Analysis Programs (CODAP) approach. Significant advances are continuing to be made in occupational analysis for military applications. Many military organizations are major users of these technologies. The major methods developed for military applications are used in the civilian world as well, in both the public and private sectors.

This report highlights recent research advances and applications of military OA technology. It is designed to bring military psychologists up to date concerning OA technology for military applications and the impact that military occupational analysis is having on civilian practice. First, the history of occupational analysis R&D and application in military organizations is reviewed, to establish the context for ensuing chapters covering current military OA R&D results and applications. The various chapters address OA in both U. S. and allied nations' service organizations. In addition, civilian applications of military OA technology are discussed. Finally, future directions for OA are highlighted. The potential use of OA methods for modeling organizational structure, and for informing organizational interventions (e.g., job enlargement, training, technostructural change), is also discussed. The final chapter includes a proposed research agenda for future military occupational analysis R&D based on comments received from symposium discussants.

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PREFACE

This document is a compilation of papers presented in a symposium entitled "Military Occupational Analysis: Issues and Advances in Research and Application" at the Eighth International Occupational Analysts Workshop held in San Antonio, Texas, on 15-17 June 1993. The symposium was chaired by Dr. Hendrick W. Ruck, then Chief Scientist of the Armstrong Laboratory's Human Resources Directorate.

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SUMMARY

Historically, some of the most significant research and development (R&D) in occupational analysis (OA) has been accomplished by military organizations for military applications. Several of the most important OA methodologies were developed under military sponsorship. Examples include functional job analysis, worker-oriented approaches (the Position Analysis Questionnaire, the General Work Inventory, etc.), and the Task Inventory/Comprehensive Occupational Data Analysis Programs (TI/CODAP) approach. Significant advances are continuing to be made in occupational analysis for military applications. Many military organizations are major users of these technologies. The major methods developed for military applications are used in the civilian world as well, in both the public and private sectors.

This report highlights recent research advances and applications of military OA technology. It is designed to bring military psychologists up to date concerning OA technology for military applications and the impact that military occupational analysis is having on civilian practice. First, the history of occupational analysis R&D and application in military organizations is reviewed, to establish the context for ensuing chapters covering current military OA R&D results and applications. The various chapters address OA in both U. S. and allied nations' service organizations. In addition, civilian applications of military OA technology are discussed. Finally, future directions for OA are highlighted. The potential use of OA methods for modeling organizational structure, and for informing organizational interventions (e.g., job enlargement, training, technostructural change), is also discussed. The final chapter includes selected comments from symposium discussants regarding a proposed research agenda for future military occupational analysis R&D.

I. MILITARY OCCUPATIONAL ANALYSIS: AN HISTORICAL OVERVIEW

Jimmy L. Mitchell
Walter E. Driskill

Primoff and Fine (1988) have observed that "the history of job analysis is essentially a history of individuals undertaking to satisfy certain needs for information about jobs in order to deal with practical personnel problems" (p. 14). They attribute the Civil Service reform movement after the Civil War with creating the drive for more realistic job information and better personnel selection, as an alternative to the political spoils system for filling Federal jobs. They also note the following:

> Initially, the methods used to obtain the information appear to have been readily available observation, interviewing techniques with knowledgeable people, or simply deduction based on assumed knowledge. Only in the past century with the introduction of scientific management, has there been a focus on the methodologies of fact gathering as such. (p. 14)

During World War I, Walter Dill Scott and Walter VanDyke Bingham headed a Committee on Classification, a group of noted psychologists who were charged with improving personnel testing and placement for the U. S. Army. This project resulted in the Army Alpha and Beta Tests for selection and classification of recruits (DuBois, 1970). Scott recommended an integrated personnel system with complete cross-referencing between military and civilian skills and specifications for each job; he also suggested trade tests to determine individual skill levels. Scott's goal was to match people and jobs properly to optimize performance and provide for individual development (Mitchell, 1988).

Shortly after the end of World War I, Scott set up his own company and introduced to business and industry the job analysis procedures developed in the Army. In 1922, the U. S. Civil Service Commission tasked R. C. Clothier, a vice president of the Scott Company, to analyze the jobs of 1,200 civilian employees in 237 occupations at McCook Field, Dayton, Ohio, in terms of their duties, requirements, and avenues of advancement (Primoff & Fine, 1988). A prime objective of that study was to classify occupations and identify grade levels within each occupation (career progression paths). In the early 1930's, the Social Science Research Council and the National Research Council were concerned with improving job analysis for classification and placement to help remediate unemployment. This emphasis led to the development, in 1934, of the Occupational Analysis Program (OAP; later titled the Occupational Analysis Section or OAS) of the United States Employment Service (USES). The OAS was headed by C. L. Shartle until the early days of World War II (Primoff & Fine, 1988). A number of psychologists who would later pioneer job analysis methodologies of their own got their start in the USES occupational analysis program, including E. J. McCormick, E. S. Primoff, and S. A. Fine.

World War II and Subsequent Developments

During WW II, psychologists were used extensively to help improve the selection and placement of military personnel. Of this effort, McCormick (1967) noted that it "was then the most extensive program in personnel classification and assignment the world has ever known" (p. 121). He went on to say that "despite the criticisms to the contrary, both well-founded and not, it is at least my own personal conviction that those classification programs contributed significantly to the effectiveness with which the military services girded themselves for that unhappy period" (p. 121). He cited the development of a pilot selection program by John Flanagan and his co-workers at Lackland Air Force Base (AFB) as an example of significant improvement. Colonel Flanagan subsequently used similar methods, which he called a "Critical Incidents Technique," to analyze administrative officers' and research and development officers' jobs, thus creating another job analysis methodology.

In 1946, Shartle called for establishment of a national center for job analysis; he believed an integrated approach was essential to derive proper occupational information and optimize its use (Shartle, 1959). In an August 1949 memorandum from the Joint Chiefs of Staff to the Secretary of Defense, a request was made to initiate a study

> to determine the most appropriate methodology and techniques of military job analysis and job evaluation; determine the extent to which the unilateral analyses accomplished to date are valid with relation to methodology; provide for such further job analysis as may be required; and initiate a study to relate all Army, Navy, and Air Force jobs to a common occupational structure." (Van Cleve, 1974, p. 65)

In the 1950's, Rupe (1952, 1956) studied several Air Force job analysis methods and recommended adoption of a checklist survey method; this suggestion met with considerable resistance even though several members of the Air Staff pleaded for an aggressive occupational research program (Christal, 1974a). Finally, in late 1957, Headquarters United States Air Force (HQ USAF) directed that an occupational research project be established. It took another 10 years to develop an operational Air Force occupational analysis program, which was finally implemented in July 1967. This program included initial operational use of the Comprehensive Occupational Data Analysis Programs (CODAP); a number of additional years were required to get it institutionalized in the classification and training communities within the Air Force (Christal, 1974b; Mitchell, 1988; Morsh, 1964).

Throughout the 1950's and 1960's, several military job analysis methodologies continued to be used by the various services; several proved difficult to use or too expensive to sustain (Van Cleve, 1974). The advantage offered by the Air Force's task inventory, CODAP-based program was the capability to obtain and analyze detailed task information from large numbers of job incumbents. Of this work, McCormick (1967) wrote:

> The pioneering work of the Personnel Research Laboratory...is particularly noteworthy. They have developed and used job inventories, consisting of lists of job tasks in a given career field, as a means of mass collection of job information from job incumbents. This technique, in combination with certain associated statistical procedures (which they have also developed), has made it possible to describe jobs in quantitative terms and to express job relationships in quantitative terms. (p. 122)

The Task Inventory/CODAP Approach

The research came about when the demands of managing personnel in a rapidly changing, high-technology workplace became clear (Rupe, 1956; Thorndike, Hagen, Orr, & Rosner, 1957). These demands generally fell into the broad categories of classification, job evaluation, testing, and training. Early in this line of research, it became clear that a detailed understanding of Air Force jobs was essential to all these goals (Morsh, Madden, & Christal, 1961). At the same time, the potential impact of the electronic digital computer was being recognized (Christal, 1974a; Morsh & Christal, 1966). Although all the problem areas were being researched, the first gains were in the area of classification. These gains were due, in part, to two major advances. The first advance was the validation of scientific methods for developing standardized, individual job descriptions (Archer, 1966; Archer & Fruchter, 1963). The second advance was the development of an analytic tool, hierarchical clustering, which used those descriptions to define empirical subdivisions of given occupational areas (Ward, 1961).

Early studies had shown that the best information for classification purposes was "time spent" data from job incumbents (McCormick, 1960; McCormick & Tombrink, 1960). Many of these same early studies also examined job incumbents' "self-report" of training needs, without much success. These self-report studies included analysis of task "physical difficulty" and "mental difficulty." Other early studies examined self-reports of task "training emphasis," "difficulty to learn in on-the-job training (OJT)" (Morsh, 1965), and "worker-supervisor agreement on difficulty" (Madden, Hazel, & Christal, 1964). Based on this research, it was decided that training requirements data would best be collected from senior supervisory personnel.

Task Factor Information - Task Difficulty Ratings

Using supervisory raters, several scales were evaluated and subjected to interrater agreement analyses. It became clear that "difficulty" was multidimensional and that refinement of that concept was required in order to develop an operational system. It was determined that a measure of "task learning difficulty" would best serve the needs of the training community. First, it provided a stable, usable measure that could be collected operationally. Second, this definition of difficulty had the desirable implication of relating individual learning ability to an appropriate training course length.

Although all operational data collection had been on a relative scale within one or two highly related career fields, researchers at AFHRL (Air Force Human Resources Laboratory--now

designated the Human Resources Directorate of Armstrong Laboratory or AL/HR) were studying whether these data could be used across many, if not all, career areas by use of a benchmark scale (Burtch, 1978; Fugill, 1972, 1973). The goal of the benchmark scale research was to develop measures that could prioritize Air Force career fields in terms of learning difficulty. In addition, this measure could, on a standard scale, demonstrate the diversity of learning difficulty requirements within a career field, and perhaps suggest classification changes.

Benchmark scales were produced for the major aptitude areas. The Armed Forces Vocational Aptitude Battery (ASVAB) composites for Administrative, General, Electronics, and Mechanical were the four aptitude areas. The Administrative and General areas were then combined to yield three major areas. Tasks spanning the spectrum of within-specialty difficulty were selected for study. Contractors made field studies of the selected tasks and rated them on the appropriate 25-point benchmark scale. Analytic software was developed to generate regression equations predicting the 25-point benchmark ratings from the corresponding subset of the original noncommissioned officer (NCO) ratings of within-specialty learning difficulty. The resulting regression equations were then used to produce predicted 25-point ratings for all tasks within the original inventory. Subsequently, these 25-point ratings were used to compute, for every job incumbent surveyed, a predicted job learning difficulty index on a scale of 10 to 250. The data were summarized for the first-term, 5-skill-level airmen within the specialty. The mean and standard deviation for this group have become known as the Occupational Learning Difficulty (OLD) index for the specialty.

The OLD indexes have been produced by a lengthy, careful research and development process. However, because of the important applications in which these OLD indexes would be used, several validation methodologies were also employed. The Aptitude Requirements contractor ratings (Burtch, 1978) correlated well with the original, within-specialty ratings of difficulty. This finding increased confidence in the basic data. Subsequent research has demonstrated a construct validity with respect to training course attributes of student input, training outcomes, and course characteristics (Weeks, Mumford, & Harding, 1985). Further research might be undertaken to explore the actual tradeoff curves in the difficulty-aptitude interaction in order to enhance the accuracy of the person-job-match algorithms.

The importance of the construct of task learning difficulty for Air Force technical training is based on the assumption that it will take longer to learn a more difficult task (Christal, 1974b; Weeks, 1981). This appears to be a well-founded assumption whose corollary that the more capable individuals will take less time to learn a task of constant difficulty is well supported in the research literature (Cronbach & Snow, 1977). The recent cognitive literature further supports the concept that "time to mastery" and "response time" may be excellent indicators of problem difficulty, both at the individual and aggregate levels (Sternberg, 1982).

In a more recent study (Mumford, Harding, Fleishman, & Weeks, 1987), the construct of "occupational difficulty" (the aggregated difficulties of tasks performed within a specialty) was included in a conceptual model of the Air Force's Initial Skills Training process because Instructional System Design personnel and training managers felt that task difficulty had a

significant influence on the design of courses and on student performance. Inspection of the data collected in almost 40 training courses supported these a priori expectations; that is, the more technical courses had higher occupational difficulty indexes than did less technical courses. Weeks (1984) performed a more detailed analysis of these data, in which the pattern of relationships observed between the occupational-level index and several training criteria substantiated the validity of the learning difficulty construct.

The results of a path analysis carried out by Mumford et al. (1987) involving the student input, course, and training outcome variables included in the model showed that occupational difficulty was a prime determinant of the nature of the training course by influencing course attributes such as course length, student-faculty ratio, instructor quality, and amount of feedback provided. OLD was shown to have a negative effect on the quality of student performance; that is, the more difficult the tasks within a specialty, the poorer the quality of performance in training. These findings further indicate the importance of task difficulty in Air Force technical training and support the need for further research on the relationship between training criteria and the task learning difficulty index.

Once task difficulty ratings for specialties have been placed on a common metric (via the "benchmarking" process), then the relative difficulty of typical jobs of all specialties can be compared in order to develop a rank-ordering of the specialties themselves. Management decisions can then be made on minimum aptitudes required for each specialty (Burtch, Lipscomb, & Wissman, 1982; Fugill, 1972, 1973). As of April 1982, such OLD data have been used to operationally redefine such aptitude requirements, and current standards are being slowly adjusted (5 percent per year) to meet the new target values (Harding, Mumford, & Weeks, 1985; Weeks, 1984). The use of task difficulty (TD) and OLD data impacts on the total distribution of all incoming Air Force enlisted personnel.

Another use of such data involves the Pre-Enlistment Person-Job Match system (Hendrix, Ward, Pina, & Haney, 1979). The OLD is one variable included in the Procurement Management Information System (PROMIS), which allocates new personnel to the available jobs; this computer-based decision system is used interactively to offer appropriate jobs to qualified individuals. The most difficult jobs are offered to the most talented enlistees of a constrained, ordered list. Once an occupational placement is made, the individual can be entered into the Pipeline Management System (PMS) to notify the Air Force Military Personnel Center (AFMPC) and Air Training Command (ATC).

Training Emphasis Data

Another task factor collected from senior technicians is ratings of how much training emphasis (TE) should be given to a task in Initial Skills Training; that is, training for the first job or first enlistment (Mitchell, Ruck, & Driskill, 1988; Ruck, Thompson, & Stacy, 1987). Senior NCOs serving in operational units in each specialty are asked (a) to check each task for which formal training of some kind is recommended for first-term airmen, and (b) to rate each of the tasks checked to reflect the degree of recommended emphasis (Ruck et al., 1987). Vaughan (1978)

noted that the ratings indicate the extent to which emphasis should be placed on each task in formal training for first-assignment airmen (i.e., at the apprentice level); he went on to observe that the ratings do not distinguish among the various forms of formal training (such as technical school, correspondence course, field training unit, and on-the-job training or OJT).

When used in conjunction with information on the percentage of first-assignment airmen performing tasks, TE and TD data can be used to evaluate Plans of Instruction for basic entry-level courses, and other training specification documents. The tasks can be reorganized into displays structured around the documents being evaluated, with task data grouped into appropriate categories for each section or paragraph. This procedure reformats the data into a form that is familiar to the field technician, training developer, or training decision-maker, yet provides concise summaries of information from a substantial proportion of career field incumbents and senior technicians. By displaying data summaries in this way, a direct validation of training in terms of tasks performed on the job can be achieved. Areas of overtraining and undertraining can be identified for review, as well as groups of tasks that may have been omitted from training specification documents.

By reviewing such summaries of occupational analysis data, functional and training managers can direct needed modifications to training documents and, ultimately, to training programs. These decisions are then validated by meeting with Air Force functional managers and representatives of user commands who employ new specialists. This extra validation step is normally conducted in a Utilization and Training Workshop (U&TW), and agreements with user organizations represent a contract as to the level of training to be provided in the initial skill acquisition courses. Implicit in this kind of agreement is the acceptance by user organizations to provide, from their own resources, any additional training (such as hands-on training and experience with equipment) not provided in the classroom. The U&TWs also permit functional managers to develop future organizational plans, such as the impending procurement of new systems or phase-out of obsolete equipment. Thus, occupational analysis data can be tempered by both user judgments and future plans for changes in the technical specialty.

This TE line of research has resulted in a variety of other research and development (R&D) programs for the prioritization of training, assistance of training decision-makers, and restructuring of occupations or specialties. The Training Decisions Modeling Technology (see Chin, Lamb, Bennett, & Vaughan, 1992; Mitchell, Yadrick, & Bennett, 1993) is based on the need to have an overall model of each specialty's jobs and training programs; any change in one job or program impacts on all parts of the Air Force specialty (AFS) in terms of training costs or capacity. This R&D area is too complex to detail here, but some of the new applications are covered in other sections of this symposium. Suffice it to say that for the Air Force, the use of TE and TD ratings has led to a variety of R&D applications which have substantially enhanced the ability of the Air Force to provide relevant and cost-effective training programs.

Other Types of Task Factor Information

A number of other efforts have been made to address task, knowledge, or skill requirements of various occupations. The Canadian National Defence Forces collect ratings from job incumbents on the levels to which incumbents are involved with the tasks of their occupations (assist, perform, teach, supervise, etc.), as well as knowledges required. The U. S. Navy collects training importance ratings from senior technicians in selected jobs in order to evaluate specific course content; the Navy also surveys supervisors of new graduates to evaluate training effectiveness for job performance (Ruck & Lang, 1986). The U. S. Army collects a variety of task ratings (task difficulty, training emphasis, training importance, part-of-the-job, real time, etc.) on skills and knowledges when requested by the proponent technical training centers to provide data for use in training evaluations or selection for various specialties (Goldman, 1991a). Other task factors or factor-weighting schemes are currently undergoing research and development (Goldman, 1991b).

Gradually Increasing Acceptance

The work of Christal and his co-workers through the years has not been an easy achievement, nor was acceptance immediate or widespread. Job and occupational analysis is not a glamorous or high visibility area on which to build a personal career or secure tenure. Bill Cunningham (1989, as cited in Harvey, 1991) has observed that it is difficult to get students interested or to get reports accepted for publication; he once characterized the job analysis area as "the Rodney Dangerfield of I/O [Industrial/Organizational] psychology: it doesn't get a lot of respect" (p. 73). The R&D community as a whole (across several academic disciplines) has generally not been enthusiastic about the largely atheoretical job analysis area.

Yet the CODAP approach to job analysis has gradually gained wide acceptance within the military services and in allied services (Mitchell, 1988). Its use has spread to the academic world, to business and industry, and to state and local government (see Figure 1). Harry Ammerman and his co-workers at the National Center for Research in Vocational Education at The Ohio State University created a central library of task lists, as well as publishing a five-volume set of booklets on the task inventory approach for determining performance content for job training (Ammerman & Pratzner, 1977). This was a major step forward in civilian application of the task-based approach to occupational analysis.

CODAP software has recently been upgraded and standardized across the U. S. and allied military services (see Chapter II). CODAP can also interface with other software systems; CODAP files can be extracted and exported to general statistical packages, such as the Statistical Package for the Social Sciences (SPSS) or SAS. Likewise, other types of data (such as Critical Incidents; Skills, Knowledges, and Ability Requirements; etc.) can and are being processed in CODAP (see Driskill, Weissmuller, Hageman, & Barrett, 1989; Moon et al., 1991). Data files are routinely exchanged among computers via tape or transmission networks, as well as among hardware systems. A microcomputer version called "atCODAP" has been created by Johnny Weissmuller and Sensible Systems, Inc. and is being used by a variety of governmental agencies

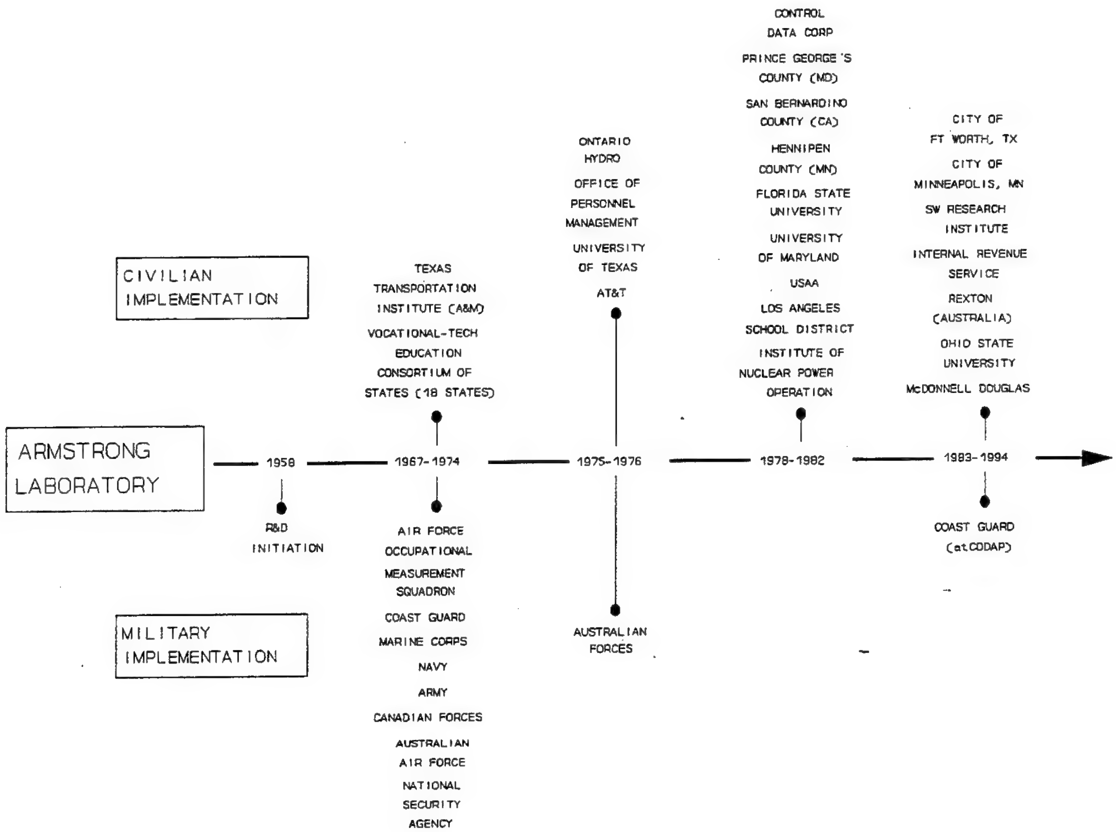

Figure 1. Transfer of CODAP technology to other military and civilian organizations.

and other enterprises (see Figure 2). This system includes automatic task inventory development, as well as computer-based survey administration and disk storage and transmittal of survey responses. A computer-based task inventory administration system is currently under development for the Air Force occupational analysis program.

As the Task Inventory/CODAP (TI/CODAP) approach has grown and matured, so have other job analysis methodologies. Among the more notable developments--some of which have been used in both military and civilian applications--are Fleishman's Ability Requirement Scales (ARS; Fleishman & Quaintance, 1984), Primoff's Job Element Method (Primoff & Fine, 1988), Fine's Functional Job Analysis (Fine, 1988), McCormick's Position Analysis Questionnaire (McCormick, 1979), and Cunningham's Occupational Analysis Inventory (Cunningham, 1988). A comprehensive review of the almost half a hundred methodologies appearing in the literature is provided in Gael (1988).

San Antonio City Public Service (McFann-Gray)
PDRI/HumRRO
City of Fort Worth (police)
City of Minneapolis (clerical jobs)
Ontario Hydroelectric (Canada)
MAXIMA (Coast Guard & Internal Revenue Service)
Southwest Research
Rexton (National Furniture Council, Australia)
Ford Motor Co. (Engineers - US, UK, & Germany)
Metrica (Internal Revenue Service)
CCA Snack Foods (Queensland, Australia)
McDonnell Douglas Missile Systems
Sam Houston State University (Texas Police)
CODAP Practitioners for NOA Australia
The Ohio State University

Figure 2. Users of atCODAP technology and services.

Evaluations of Military Occupational Analysis

Brian Moore, in a review of job analysis methodologies for the Navy, viewed modern task inventories as a synthesis of three differing approaches to job design: the engineering approach, the job content approach, and the role content approach (Moore, 1976). Moore concluded his review with the comment that "the relevance, utility, and comprehensiveness of the TI/CODAP seems to offer a significant step forward over other forms of occupational analysis" (p. 75). McCormick (1979) disagreed with Moore's assessment, although he conceded that task inventories were particularly useful for identifying job types and for planning training programs. McCormick went on to point out that "each of the various individual methods has its own potential uses, and it does not seem reasonable to believe that there is one best method that can serve all purposes" (p. 135).

Levine, Thomas, and Sistrunk (1988) evaluated a number of job analysis methodologies to determine which systems are most useful for various purposes. They utilized data from a nationwide survey of 93 leading job/occupational analysts, who rated the characteristics and utility of various established systems including McCormick's Position Analysis Questionnaire (PAQ), Fine's Functional Job Analysis (FJA), TI/CODAP, Flanagan's Critical Incidents Technique (CIT), Primoff's Job Element Method (JEM), Fleishman's Ability Requirement Scales (ARS), and Lopez's Threshold Traits Analysis (TTA). The PAQ, FJA, and TI/CODAP were generally rated among the top three methods for most uses. In addition, 80 of the 93 respondents indicated that they preferred to use a combination of two methods to meet their

needs (Levine et al., 1988). The more popular combinations included TI/CODAP and PAQ, CIT and FJA, FJA and TI/CODAP, PAC and CIT, and TI/CODAP with ARS. This survey provided a high level of visibility for TI/CODAP for the first time to academicians, human resource managers, and other job analysis practitioners.

It should be noted that at least three of these methods (TI/CODAP, PAQ, and CIT) evolved directly from military job analysis research; and at least two others (JEM and FJA), from other government agencies. Other researchers, such as Fleishman, worked closely with and were often supported by military R&D agencies. The point is that a very substantial proportion of job analysis research in this country has been directly accomplished by, or directly or indirectly supported by, the military services and other government agencies.

Current Status and Trends

TI/CODAP continues to be the primary job analytic method in the military. Some current developments, however, include the use of TI/CODAP in conjunction with other methods and approaches (Driskill et al., 1989) to address a variety of issues. Because other approaches address different kinds of task-job-worker dimensions, their use supplements the highly specific task information provided by TI/CODAP and can provide vital information not available from TI/CODAP.

Job Analytic Approaches

Differences among job analytic approaches lie primarily in their focus. Fleishman and Quaintance (1984) have suggested that methods can be classified into four categories: Behavior Description, Behavior Requirements, Ability Requirements, and Task Characteristics.

Behavior Description. Behavior description methods focus on a specification of what workers actually do while performing their jobs. Products of these methods range from highly task-specific to more general task information. Usually, emphasis is placed primarily on the overt behaviors or certain subjective terms which describe what the worker does. Several systems of job analysis representing this approach are in use, each differing from the others with respect to the level and context of the descriptive information. Included under this approach are TI/CODAP, PAQ, the Occupational Analysis Inventory (OAI), the General Work Inventory (Cunningham, Wimpee, & Ballentine, 1990), JEM, and FJA. These methods are well documented with regard to measurement and procedural issues, interrater reliability and taxonomic adequacy, job component and criterion-related validity, and utility (Driskill et al., 1989).

Behavior Requirements. Behavior requirements methods place emphasis on the classification of behaviors that should be emitted or which are assumed to be required for achieving criterion levels of performance. The human performer is assumed to be in possession of a large number of processes that serve to intervene between the stimulus and response events. These intervening processes are, in a real sense, constructs to account for human task behavior. Such approaches,

best described by the methods of Gagne (1977) and Miller (1973), have most generally been applied to the problem of human learning.

Ability Requirements. Ability requirements methods (best exemplified by Fleishman's ARS) describe, contrast, and compare jobs and tasks in terms of abilities required of the worker. "Abilities" as defined by Fleishman and Mumford (1988) and McCormick (1979) are the relatively enduring attributes of the individual performing the tasks, and certain tasks are hypothesized as requiring certain ability profiles if performance is to be maximized. The ARS consists of a taxonomy of sensory, perceptual, cognitive, and physical abilities which raters use to describe human task performance requirements.

Task Characteristics. Task characteristics methods emphasize the characteristics of the tasks that are performed. Tasks are analyzed in terms of their characteristics and their impacts on behavior and performance. A taxonomy of task characteristics includes such features as (a) number of procedural steps, (b) the dependency of procedural steps, (c) response rate, (d) procedural complexity, and (e) amount of feedback provided the performer by successful (or unsuccessful) outcomes (Driskill et al., 1989). Use of the task characteristics approach has produced important implications for learning and retention. A study in which hands-on performance measures were the criteria (Rose et al., 1984) suggests that the characteristics of tasks may be effective predictors of learning rates. Based on the kinds of descriptors used, one might hypothesize that learning difficulty ratings collected at the task level, as in the TI/CODAP method, may be effective learning and retention predictors.

Recent Trends

In a more recent effort, Driskill and his co-workers (Driskill et al., 1989) examined 36 various job analytic methods to determine how ability requirements could best be linked to task-level job data. As a result, a combination of TI/CODAP and the ARS was successfully employed. Another application demonstrated how knowledge and skill taxonomies can be used with CODAP-generated task co-performance modules to define training and testing requirements empirically (Moon et al., 1991). Linkages of this kind are essential if we are to have legally defensible occupational requirements, realistic recruiting standards, optimal classification and placement, and realistic training programs.

Such linkages are possible only if current methods are extended and a variety of methods are utilized. Recent and on-going research is addressing the use of multiple approaches, including the ARS and the Critical Incidents Technique, in conjunction with CODAP. Further, the analytic capabilities of CODAP are being extended and applied to practical personnel and training issues.

In particular, the task co-performance module technology is extremely promising for defining classification structures that optimize transfer of training and for the empirical determination of skill and knowledge requirements. Task modules have also been used extensively as a basis for modeling specialty jobs and training requirements (see Chin et al., 1992), and have high

potential utility in multilevel organizational research (Mitchell, Phalen, & Hand, 1992; Vaughan & Yadrick, 1992). In one recent experimental study, ratings of task modules on 26 skill and knowledge scales proved predictive of learning curves (training time functions); this approach has high potential for estimating training requirements of new weapon systems (Vaughan, Mitchell, Knight, Bennett, & Buckenmyer, 1990).

Task modules, particularly mission essential modules (MEMs), have recently been proposed as an appropriate level of analysis for a specialty structuring system, and for a variety of other purposes. Co-performance modules have also been successfully used in non-DoD (Department of Defense) research (see Moon et al., 1991) and appear to have a number of realistic and practical applications.

A number of recent CODAP-related research and applications efforts have been undertaken for non-military organizations and business firms, and we expect this trend to continue. There have been several uses of the new MODULE technology with civilian companies and non-DoD agencies and organizations, and there appears to be considerable interest in making further applications of military-developed job analysis technology for civilian use. This is a trend we should encourage and foster; we need to find ready application of such technologies in the civilian sector if we hope to be able to justify further R&D in the future. The U. S. military services can no longer afford to be <u>the</u> primary source of funding for this very significant area.

II. INNOVATIONS IN OCCUPATIONAL MEASUREMENT TECHNOLOGY FOR THE U. S. MILITARY

William J. Phalen
Jimmy L. Mitchell

The principal occupational analysis technology in the United States Air Force is the Task Inventory/Comprehensive Occupational Data Analysis Programs (TI/CODAP) approach. This system has supported a major occupational research program within the Air Force Human Resources Laboratory (AFHRL; now the Armstrong Laboratory, Human Resources Directorate) since 1962 (Christal, 1974b; Morsh, 1964), and an operational occupational analysis capability within Air Training Command's USAF Occupational Measurement Squadron since 1967 (Driskill, Mitchell, & Tartell, 1980; Weissmuller, Tartell, & Phalen, 1988). The CODAP system is now used by all the U. S. and many allied military services, as well as a number of other government agencies, academic institutions, and some private industries (Christal & Weissmuller, 1988; Mitchell, 1988).

The TI/CODAP approach to job analysis is generally recognized as being particularly relevant for a number of human resource management (HRM) uses including job descriptions, identification of training requirements, and modeling career paths (McCormick, 1976). In the early 1980's, a survey of 100 leading U.S. job analysts evaluated six major job analysis systems on a number of utility dimensions, such as cost and time to complete, and for a variety of HRM uses such as evaluation, performance appraisal, and training (Levine, Ash, Hall, & Sistrunk, 1983). The TI/CODAP approach to job analysis, along with McCormick's Position Analysis Questionnaire (PAQ; McCormick, Jeanneret, & Mecham, 1972) and Sidney Fine's Functional Job Analysis (FJA; Fine & Wiley, 1971), were consistently rated among the top three for most HRM uses (Levine et al., 1983). Significantly, three of the six major job analysis systems in the U. S. (Critical Incidents, PAQ, and TI/CODAP) were developed in military-funded job analysis research; such military-sponsored R&D has had a substantial and lasting impact on the study of jobs in this country (Mitchell, 1988).

In assessing the current state of job analysis technology in America, Harvey (1991) has recently noted:

> Advances in computer technology have allowed the development of integrated personnel systems to manage the vast amounts of data generated during the job analysis process. Applications of artificial intelligence and expert-systems technology promise to further reduce the cost and labor-intensiveness of the job analysis process. (p. 71)

A good bit of this work has already been done, is in progress, or is planned for the near future by the military occupational analysis community.

In recent years, the CODAP system has been rewritten to make it more efficient and to expand and partially automate its capabilities (Phalen, Mitchell, & Staley, 1987). In the process of developing this new ASCII CODAP system, several major innovative programs were created to extend the capabilities of the system for assisting analysts in identifying and interpreting potentially significant jobs (groups of similar cases) and task modules (groups of co-performed tasks).

Over the last several years, operational testing and evaluation of new ASCII CODAP interpretive software has continued, and these programs have demonstrated their value in terms of enhanced analytic capabilities and their potential to accelerate completion of an occupational analysis.

A Suite of Advanced Interpretive Assistance Programs

A set of seven programs has been developed to assist analysts in interpreting job and task clusters. Some of these programs were completed in time to be released with the initial version of ASCII CODAP; others required further refinement before they were ready for operational use. It is helpful to have an overview of the entire set of programs, so everyone can see how the programs relate to one another and to their ultimate objective. These programs are shown in Figure 3.

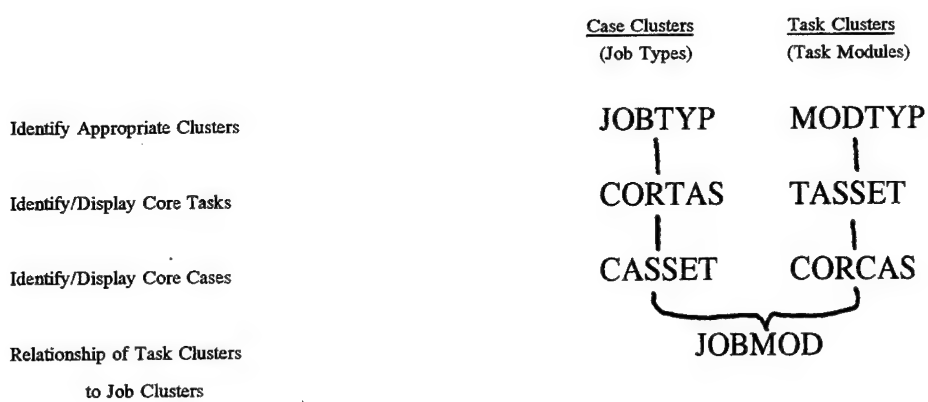

Figure 3. The Set of Advanced Interpretive Assistance Programs.

Program Descriptions

These programs may be briefly described as follows:

JOBTYP. The JOBTYP program automatically identifies stages in most branches of a hierarchical clustering DIAGRM which represent the "best" candidates for job types. First, core task homogeneity, task discrimination, a group size weight, and a loss in "between" overlap for

merging stages are calculated for all stages and these values are used to compute an initial evaluation value (for JOBTYP equations, see Haynes, 1989). The value is used to pick three sets of initial stages; these are then inserted into a super/subgroup matrix for additional pairwise evaluation, in order to further refine the selection of candidate job type groups. Three final sets of stages (primary, secondary, and tertiary groups) are then reported for the analyst to use as starting points for selecting final job types.

CORTAS. The CORTAS program compares a set of group job descriptions ("contextual" groups) in terms of number of core tasks performed, percent members performing and time spent on each core task, and the ability of each core task to discriminate each group from all other groups in the set (Phalen & Weissmuller, 1981). It also computes for each group an overall measure of within-group overlap called the "core task homogeneity index," an overall measure of between-group difference called the "index of average core task discrimination per unit of core task homogeneity," and an asymmetric measure of the extent to which each group in the set qualifies as a subgroup or supergroup of every other group in the set.

CASSET. The CASSET program generates displays of cases whose jobs are most representative of job types within a given set of job clusters. This approach permits an analyst to quickly characterize a job type by the salient features of its most representative and discriminating members. The CASSET report may contain any type of background variable information describing a case that will fit in the allocated space. "Base of assignment" and "job title" are often the most useful variables to aid analysts' interpretations.

MODTYP. Just as the JOBTYP program automatically selects from a hierarchical clustering of cases the best set of job types, based on similarity of time spent across tasks, the experimental MODTYP (module typing) program selects from a hierarchical clustering of tasks the best set of task module types, based on task co-performance across cases. The term "best" means that the evaluation algorithm initially optimizes on four criteria simultaneously (i.e., within-group homogeneity, between-group discrimination, group size, and drop in "between overlap" in consecutive stages of the hierarchical clustering). After all stages of the clustering have been evaluated on these criteria, primary groups are input to the TASSET and CORCAS programs to provide analytic and interpretive data for each task cluster (Phalen, Staley, & Mitchell, 1989). Task clustering using co-performance values as a basis for developing task modules (TMs) has been reported elsewhere and need not be detailed again here (Mitchell, Phalen, & Hand, 1991; Perrin, Knight, Mitchell, Vaughan, & Yadrick, 1988; Vaughan et al., 1989). Task co-performance is defined as a measure of the similarity of pairs of task profiles across all the people in an occupational survey sample. Details of the computation of measures of task co-performance may be found in Rue, Rogers, and Phalen (1992).

TASSET. TASSET is a program that compares clusters of tasks (modules) in terms of the degree to which each cluster of tasks is co-performed with every other task cluster (supergroup/subgroup matrix). TASSET computes the average co-performance of each task with every other task in each cluster (representativeness index) and the difference in average co-performance of the same tasks with all other task clusters (discrimination index). TASSET also identifies tasks

that meet the co-performance criterion for inclusion in clusters in which they were not placed (potential core tasks), as well as tasks that are highly co-performed with clusters other than the target cluster (negatively unique tasks).

CORCAS. The CORCAS program characterizes a task cluster (module) in terms of the people who most perform the tasks in the cluster, and especially those principal performers whose jobs are concentrated in this task cluster to the exclusion of all or most other task clusters. The CORCAS report may contain any type of background variable information describing a case that will be useful to the analyst in interpreting the task cluster and which will fit in the allocated space, just as on a PRTVAR report; however, "base of assignment" and "job title" are often the most useful variables.

JOBMOD. The JOBMOD (job type versus task module mapping) program aggregates the case- and task-level indexes computed by the four advanced analysis programs and uses these aggregate measures to relate task clusters to job types and vice versa. The description of job types by a handful of discriminant clusters of tasks, and the association of each task cluster with the types of jobs of which it is an important component, is a basic requirement for defining and integrating the manpower, personnel, and training (MPT) components of an existing or potential Air Force specialty (AFS) or weapon system. If AFSs are to be collapsed or shredded out, or new jobs are to be assigned to an occupational area, or old jobs are to be moved to another occupational area, such highly summarized yet meaningfully discriminant hard data are essential (Phalen et al., 1989).

Discussion

The work on CODAP programs for selecting and interpreting task clusters has been highly successful, and we have only begun to tap the potential of this type of automated modular technology. Further, our work with TMs to date has led us to believe that the task module approach has real promise for simplifying and expanding the use of occupational information in helping executives and managers make more realistic decisions. It is, in fact, a critical technology in the current period of manpower and budget reductions and consolidations. It is more important than ever to be able to model proposed changes and assess the potential impact of such changes before final MPT decisions are made.

We believe that the automated modular technology can be extremely useful in modeling occupations and the world of work (Mitchell, Phalen, & Hand, 1992; Weissmuller, 1978). With additional refinement, we should be able to use quite a variety of information to develop better TMs which will take into account the type of equipment operated or maintained, as well as subject-matter expert (SME) ratings such as training emphasis (TE) and task difficulty (TD). Though not yet fully explored or validated, this emerging TM development methodology has great promise for significant improvement of military manpower, personnel, and training planning and decision-making, and, indeed, for organizational analysis as well. These are, of course, the first steps toward a fully automated interpretive (artificial intelligence or AI) system.

We have detailed the development and operational testing of the new CODAP analyst assistance programs at previous International Occupational Analysts Workshops (Mitchell, Hand, & Phalen,1991; Phalen, Mitchell, Staley, 1987; Phalen, Staley, & Mitchell, 1987) and at Military Testing Association annual meetings (Mitchell & Phalen, 1985; Mitchell, Phalen, & Hand, 1991, 1992; Mitchell, Phalen, Haynes, & Hand, 1988; Phalen, Mitchell, & Hand, 1990; Phalen, Staley, & Mitchell, 1988). Indeed, such conferences have become the primary forums for interaction among CODAP practitioners.

New Work In Progress

There are a number of projects currently underway to further improve the TI/CODAP technologies in terms of better data collection, improved scales, and the capability to link task data with equipment or systems operated or maintained, required skills and knowledges, and other relevant dimensions.

Computer-Based Survey Technology

One of the most innovative current projects is the Automated Survey/Tailored Task List system, a computer-based occupational survey administration system being developed to meet a request from the USAF Occupational Measurement Squadron and Air Training Command. The capability to tailor task lists, needed for inventory development, also meets a requirement of the Base Training System project in the Human Systems Center/Systems Program Office (HSC SPO) to be able to integrate task lists (as specialties are merged, as in RIVET WORKFORCE).

The objective of the project is to develop automated procedures that provide for electronic distribution of task-level surveys to respondents, automated self-administration of the surveys on PCs, and the flow of electronically captured response data to USAFOMS on communications lines such as the Military Data Network (MILNET). This paperless survey administration system will result in substantial reductions in costs and the time it takes to collect required survey data. The more timely collection, analysis, and reporting of data should benefit all users of occupational analysis data.

An important aspect of the R&D has been the development and testing of five scaling techniques for measuring time spent on a task:

1. a criterion set of scales that provide absolute measures of frequency of task performance, time it takes for a single performance of the task, and total amount of task time spent per week, month, and year on the task;

2. a three-stage scaling technique that begins with administration of the usual 9-point relative time spent scale (stage one), proceeds to a refinement phase in which tasks assigned the same rating are displayed together and moved to another rating category if appropriate (stage two), and ends with a phase that offers the opportunity to further subdivide the tasks within each rating category into two or three subcategories (stage three);

3. an end-anchored graphical scale that displays a horizontal line, 80 characters long, with the individual's previously determined highest and lowest time spent tasks displayed at each end of the scale (as each task is presented, the rating is made by moving the cursor along the line to the desired distance between the highest and lowest time spent tasks);

4. a direct-magnitude estimation scale that uses a previously identified "moderate" time spent task as the anchor with an assigned value of 100, and each task presented for rating is assigned a value relative to the anchor task (e.g., if the task to be rated is twice as time-consuming as the anchor task, it should be assigned a value of 200; if half as time-consuming, 50); and

5. an indirect-magnitude estimation scale that consists of nine verbal expressions of amount of time spent, such as "very little," "fairly much," "a great amount," which have been weighted by means of magnitude scaling as to the amount of time each expression represents compared to the term "some." The rater responds by highlighting the appropriate expression.

On each scale, multiple feedback loops have been provided to solicit respondent evaluation and refinement of responses. When all task responses have been compiled, a complete description of the job is presented to the incumbent for final review and editing. This description gives the estimated hours per week and per month spent on each task by the respondent. These estimates were made possible by linking several of the scale responses to the absolute measures provided by the absolute time estimation scale and averaging multiple linear fits to the experimental scale data. This technology promises to give much better estimates of "real time expended per task" than have previously been possible in the pencil-and-paper mode.

Pilot testing of the automated survey system has been completed, and the software and procedures have been refined. The principal test of the automated survey administration procedure and the experimental scales will take place in a controlled laboratory environment at the Learning Abilities Measurement Program (LAMP) facility at Lackland AFB during August and September 1993, during which time the scales will be administered twice (at 2-week intervals) to a sizable sample of high- and low-aptitude airmen in a wide variety of technical and nontechnical specialties. Built-in validation procedures will include: (a) asking the respondent to indicate which tasks in the job description he or she did on the day before taking the survey and comparing these responses to the frequency and time spent data on the rated tasks across all respondents (there should be a fairly high correlation if the survey procedure is valid), and (b) asking the respondent to select the time spent value which he/she considers to be most accurate when there is a large discrepancy between the criterion and the experimental scale values (the source of each value will not be revealed, so as not to bias the responses; the chosen value should most frequently be the one from the criterion scale, if it is truly a valid criterion).

The expected payoffs of the automated survey technologies are many:

1. Elimination of printing, mailing, return, and data entry costs of over $1,000,000 per year.

2. More rapid field surveying of respondents (reducing the process from 7-9 to 1-2 months).

3. Potentially more valid and reliable data (due to tailored presentation and feedback loops).

4. Potentially more effective and efficient occupational analysis.

5. The ability to do spot surveys on an as-needed basis or annual resurveys at a stated time, rather than blanket surveys every 2 to 8 years.

6. Potentially invaluable tools for conducting management engineering, productive capacity, and performance measurement studies (which require measures of real time).

The Tailored Task List software is designed to guide the respondent through lengthy task lists in the most efficient manner, so that the respondent will not encounter tasks that have a low probability of being performed by him or her, given his or her prior task responses. The Tailored Task List procedure can also be used in conjunction with the computer-administered survey system to rapidly develop job descriptions and associated real-time estimates for tasks in order to establish organizational manpower requirements. A potentially high-payoff opportunity for this PC-based software is its ability to rapidly develop (at the hands of local supervisors or OJT trainers) task training lists tailored to the task-level training requirements of an organization and its individual workers. It may similarly be used at Utilization and Training (U&T) conferences by functional managers to help develop task training lists tailored to meet Air Force specialty (AFS), shredout, weapon system, or other general or specific task-level training requirements.

The Automated Survey/Tailored Task List system project has a very significant potential to positively impact the occupational analysis programs of all the military services, through better scaling and computer-based surveying. By using the electronic transfer of inventories and completed case data files, it should also encourage similar electronic transfer of completed reports and analysis files. This process is already underway, to a considerable degree, in the work USAFOMS is doing in support of the Base Training System (BTS). Here specially sorted job descriptions are used as input files from which the BTS develops generic position descriptions as well as the master task lists for each specialty.

Multilevel Analysis of Task Data

There are extensive amounts of task-level information now available on most military occupations, which are used effectively for a variety of purposes. Organizing such task information into task modules, jobs, and higher-order categories allows the data to be applied to more global issues and problems, and the summarized data can be used to develop more realistic models or simulations of occupational structures and requirements (Perrin et al., 1988; Vaughan et al., 1989). Existing data already permit comprehensive organizational modeling. Some present analyses involve multiple specialties, multiple categories of personnel (enlisted, officer, civilian), or even multiple services (interservice or joint-service projects). Given the substantial value of task-based information and analyses, multilevel studies focused on task modules and other higher-order groupings have considerable potential for applications in

modeling military organizations to assist military decision-makers in evaluating proposed organizational restructuring, interventions, and/or other organizational changes (Mitchell, Phalen, & Hand, 1992).

Current experimental work is focusing on adjusting the task clustering algorithm or expanding the task co-performance similarity matrix to yield more interpretable groupings of tasks, so as to distinguish meaningful subgroups among the large numbers of commonly performed tasks. We need to be able to develop multilevel taxonomies of variables which can be linked, either directly or indirectly, with tasks or groups of tasks (TMs) and with knowledges, skills, and abilities (KSAs)--potentially at many different levels.

These linkages could be estimated directly, by having SMEs map the KSAs required for every task. This is a formidable undertaking in terms of the sheer volume of tasks and potential KSAs. It can and is being done in some circumstances (see, for example, Weissmuller, Dittmar, & Moon, 1993). The same type of linkage can be achieved indirectly by having job incumbents rate the tasks they perform in their jobs, and subsequently identify and rate the KSAs they use in their jobs. The tasks and KSAs can be clustered separately, and linkages between the task modules (TMs) and the KSA modules (KMs) can be established by determining the commonality of cases involved in both the TM and KSA clustering solutions, as reflected by their CODAP CORCAS indexes. Other measures might include evidence generated directly from paired comparisons of task ratings with KSA ratings across all cases in the sample. For example, if a task rated high on time spent (salient task) is associated with a zero-rated KSA by a significant number of cases, it can be assumed that this task and KSA are not linked; whereas, if there is a significantly high correlation between a task and a KSA when both have non-zero ratings, one can assume that there is a linkage between them.

Another indirect linkage technology being developed involves the use of graph theory to establish degrees of "connectedness" (e.g., similarity or dominance) between items for which only a small number of direct comparisons are available. For example, if task A is estimated by one rater to be similar for weapon systems X and Y, and is also estimated to be similar for weapon systems Y and Z by a second rater and for systems V and Z by a third rater, we can say that X and Z are one-connected through Y, and that X and V are two-connected through Y and Z. In this manner, it is quite possible to build nonredundant connectedness networks which yield several times as many indirect linkages as the direct linkages furnished by the raters.

This technology will make it possible to perform complex occupational analyses requiring large numbers of paired comparisons, yet requiring only a limited number of raters who have compared relatively small subsets of items (e.g., four to six weapon systems) per task.

Semantic Analysis

Another emergent technology falls under the heading of Semantic-Assisted Analysis Technology (SAAT). SAAT actually covers a set of analysis principles which have been converted into unique computer code for a variety of specific applications since its initial conception in 1984.

The purpose of SAAT is to provide a linkage table (mapping) from items in one data set into matching items in another data set. This may be mapping tasks from one job inventory into another (such as Time 1 - Time 2 analysis or merging AFSs), mapping tasks into testing areas for promotion tests (Dittmar, Weissmuller, Haynes, & Phalen, 1989), mapping tasks into Maintenance Data Collection (MDC) records of work performed, or mapping tasks into Logistic Support Analysis Records (LSARs). Once the linkage table has been established, the task-level data can be summarized and used for the purpose at hand.

Currently, SAAT operates on well-structured lists of items, such as task statements or descriptions of individual data items. Because of the clear syntax used in these lists, determining parts of speech for the noun and verb phrases is straightforward. The SAAT involves a noun and verb similarity assessment, with procedures for compensating for abbreviations, acronyms, misspelled words, plural and other word forms, and synonyms (if desired). Without further linguistic development, semantic-assisted clustering can be tailored to improve the definition of task co-performance modules by measuring the strength of semantic linkage of the component task statements comprising a task module with another task module, even though general performance levels differ (e.g., subset vs. superset modules).

Additional work is planned to expand the linkage methodology to link task statements into paragraphs, sections, and chapters of textual training materials (such as Career Development Courses and technical manuals); such expansion would require an enhanced linguistic analysis process to properly parse and relate sentence fragments. This process will also require using additional dictionaries and thesauruses in which words are labeled as parts of speech (adjective, adverb, etc.) and synonymous terms are identified, and in which rules of grammar operate. Given this expanded capability, it would be possible to use logic rules (such as the law of transitivity) to establish relations between tasks or task modules and weapon systems, other equipment, or procedures, which themselves are linked with required knowledges, and probabilistic measures (based on frequency of co-occurrence of words and word combinations in a well-defined context). An extended matrix of relationships between TMs or jobs versus weapon systems or other equipment operated or maintained can be developed, which would be extremely useful in determining job requirements (KSAs, educational background, training, etc.) for optimal person-job matching. The key to optimizing such person-job matches (and thus to improved productivity) is the realistic determination of real job requirements (Ward, Vaughan, Mitchell, Driskill, & Ruck, 1992).

Future Requirements

Although much has been accomplished in recent years, and much is planned in the near future, much still remains to be done to improve and refine military occupational analysis technologies. We need future basic research into the nature of tasks and the construction of meaningful task modules and higher-level aggregations of work. We will need your help in developing a realistic statement of the requirement for this work, as well as in finding appropriate funding. We also need further applied research to further enhance the automated analysis programs and bring them more into the realm of state-of-the-art Artificial Intelligence. Again, your help is needed in

defining, justifying, and funding this advanced development work. Finally, we also need your support and money to enhance CODAP software and make it more user-friendly and interactive on RISC and PC computer systems. Given recent advances in such hardware systems, we should be aiming for an analysis system where each occupational analyst can run CODAP interactively on his or her desk-top computer, thus ending our reliance on expensive mainframe systems and batch operations.

III. THE TEAM APPROACH TO OCCUPATIONAL ANALYSIS IN THE CANADIAN FORCES

Captain L. M. Phillippo
G. J. Higgs

The Canadian Forces (CF) are a fully integrated service with a single military occupational structure (MOS). Occupational analysis (OA) is the principal means applied to evaluate the appropriateness of the MOS for meeting current and future operational requirements, its value being that it can best determine or validate the job performance requirements on which the structure is based. In order to evaluate and develop occupational structures, however, the OA effort shifts from simply producing job descriptions to the more complex process of packaging those job requirements in a rational way to meet operational, organizational, and personnel management requirements.

Occupational structure dictates the employment patterns within an occupation, and the career paths for individuals. The content of the occupational specifications produced from job data will, in turn, drive such things as training. In the CF, the occupational analyst enters the world of occupational structure, or military classification, and therefore must become involved in the structure development process and must have access to information that is not typically accessible through the job data base alone. Operational doctrine, equipment maintenance doctrine, and future perspectives with a view to the changing nature of jobs and force structure through downsizing are but a few of the variables which can have a significant impact on the eventual jobs to be performed and the occupational structure or personnel management framework that is placed around these jobs. The CF has developed a highly interactive and successful multimethod OA process to meet its needs. A key ingredient in this process is the use of a full-time OA project team to carry out all phases of work in an OA project. Prior to a description of the composition and operations of this team, the rationale for its employ should be discussed.

Multimethod Process

As an applied science, OA is used to identify the job performance requirements from which a large number of human resource activities flow. The job analysis methods available are bewildering in both number and variety. Though there is scant research on the subject, the few comparisons made of different OA methods indicate that there is no single method that can meet all of the needs of every client (see, for example, Ash, 1988). As each method yields different data products, it seems reasonable to expect that each would be differentially suitable across applications. Figure 4 illustrates the major direct uses made of OA data in the CF, with each application routinely accomplished by OA teams denoted by an asterisk.

Although Task Inventory TI/CODAP has been at the heart of the CF OA methodology for over the past 20 years, it has been necessary to venture into new ways of using the very powerful CODAP software for the handling of other than task taxonomies, such as knowledge and skill

items. In its aim to find the ideal method, the CF has developed an approach that embraces features from several different practiced OA methods and which guides a dedicated project team to fulfilling the wide-ranging project objectives and structure mandate previously mentioned. With a view to gaining maximum benefit from an OA project, senior personnel managers and commanders have generally endorsed the approach because it remains objective but ensures, and demands, their involvement throughout the life of the project.

* Occupational structuring (classification)
* Occupational specification writing
* Job description writing
Manpower planning
* Employment and career progression planning
* Training
Organizational planning
Recruiting and selection
Performance evaluation
Compensation and benefits
Occupational data retrieval

(Note: * denotes duties fulfilled by OA teams)

Figure 4. Applications of OA data in the Canadian Forces.

The OA Team

From the list of data applications in Figure 4 one can deduce the need for a level of expertise not typically found in any one occupational analyst. One can also deduce that some of these applications cannot be finalized by the analyst alone. The job expert, or occupational representative, is essential to their accomplishment. These facts dictate, to a large extent, the need for a full-time OA project team to carry out the work.

Team Composition

A typical OA project team is comprised of a team leader, staff analyst(s), and subject-matter expert(s).

Team Leader. The team leader is an experienced analyst who has been an understudy for at least one complete OA project and is the team's working supervisor, who assigns and

monitors the duties and tasks of team members, and who generally oversees or directs all aspects of team operations and administration in meeting project milestones and objectives. As is the case with all CF military officer analysts, the team leader is at the captain rank level and will be from either the Personnel Selection Officer (PSEL) or the Training Development Officer (TRGDEV) military occupational code (MOC). These selected officers will typically spend 3 to 4 years in the OA specialty area. Given the broad and comprehensive mandate of CF OA projects, the training and development of team leaders is an investment that suffers from military rotation. To maintain the necessary level of continuity and expertise on the team, it is planned to have civilian staff analysts assigned to OA teams in the future.

Staff Analyst(s). Staff analysts consist of junior officers from the PSEL and TRGDEV MOCs and senior-ranked noncommissioned members (enlisted grade) from several different MOCs. As mentioned previously, these individuals fill permanently established billets for 3 or 4 years; from their ranks future team leaders are selected.

Subject-Matter Expert(s). Each MOC being studied is represented by one or more of its members, who are assigned to the Directorate of Manpower Planning (DMP) for the duration of the project. The number of SMEs assigned depends upon the scope of the project, the size of the MOC being reviewed, and the diversity of work performed. The most important of the criteria for selection of an SME is the individual's experience in, and knowledge of, the basic jobs of the MOC; therefore, the SME is usually in the rank of captain/major or warrant officer/ master warrant officer. The SME is expected to perform, at a basic level, all of the tasks of a new staff analyst, while continuously providing expertise and practical understanding of the MOC. Although the senior SME may in some instances out-rank the team leader, rarely is there conflict, as each has a job to do and must complement the other throughout the project. The team leader knows the direction that must be taken by the team, and the SME provides the expert advice that overcomes many OA procedural and coordination problems.

Training

The team is provided with a series of formal in-house training sessions which are phased-in to precede each phase of the OA project. Through these sessions and on-the-job training, the team as a whole learns the concepts and procedures of the OA process including performing background research; interviewing techniques; inventory development; field administration of the OA questionnaire; data analysis; conducting a training needs analysis; developing employment and career patterns; evaluating or developing occupational structure; and production of draft occupational specifications.

The Team Concept: Strengths and Weaknesses

Strengths

There are obviously many advantages in having a full-time project team to perform the wide variety and large number of team tasks during a typical OA project in the CF. These include:

1. Continuity and Consensus. Because the team as a whole participates in all phases of an OA, a high degree of understanding of the problems in an MOC is developed; continuity of thought usually prevails in the interpretation of the data collected; and consensus is easier to achieve on how to handle and apply the analysis findings to correcting problems. This is particularly so when dealing with aspects of occupational structure or when developing career patterns for an MOC.

2. Pooling of Resources. In the small CF OA Section, only a project team is capable of accomplishing the large number of team tasks within a reasonably short period of time.

3. Leadership Opportunity. For the team leaders, who are at the junior officer rank level, managing and guiding a team through the complex OA process is an excellent opportunity for applying and displaying leadership skills.

4. Learning Opportunity. For new analysts, the opportunity to learn and develop analytical skills and to practice these skills as members of a team engaged in an active project is the optimum learning experience.

5. Benefits of the Team SMEs. Employing SMEs for the duration of the project is a small investment on the part of project sponsors, given the potential impact the OA recommendations can have on an occupation. Their education in the OA process and the training they receive in analysis techniques, combined with their expert knowledge, is invaluable to the team. Because they share common analyst training, they can acquire reasonably quickly many of the analyst skills and enhance the quality of the team's work in such areas as (a) inventory/questionnaire development; (b) advising on jobs and incumbents for observation and interview; (c) facilitating contact with user commands, other participants, and the project sponsor; (d) providing a practical understanding of the jobs and job relationships; (e) interpreting the data; (f) understanding the process of building occupational structure based on valid job requirements and not on personal whim or bias; (g) producing follow-on analysis products such as drafting new occupational specifications; (h) acquiring a level of objectivity that results in well-reasoned thought behind project report recommendations; and (i) helping to communicate, legitimize, and market project results.

Host SMEs become highly knowledgeable about their occupation, and many become very capable analysts. Their post-project employment frequently takes advantage of the benefits of their team tenure. They also become much more valuable to their occupational managers, a factor which can generally be of benefit to their careers.

Weaknesses

Some weaknesses in using the team concept include:

1. Cost. The full-time employment of SMEs is obviously costly; however, this cost can be viewed as money well spent, in that extremely accurate statements of job requirements are determined, leading to MOC training economies along with the other benefits mentioned above.

2. Possible Biases of SMEs. SMEs may embark on an OA with hidden personal agendas or biases relating to how they think an occupation should be structured. Such bias may hinder their ability to be objective, even in the face of hard data. This kind of situation has been rare in the experience of DMP and can usually be mitigated by good personnel management by the team leader and through structured analyst training.

3. Inexperience of SMEs. There are no "overnight analysts." It is, of course, unreasonable to expect SMEs to be instantly capable of a complete and immediate understanding of the complex concepts of OA. However, SMEs can be, and usually are, highly productive throughout the project and often progress, through natural personal aptitude, just as quickly as new staff analysts.

4. Possible Job Dissatisfaction. The fact that team tasks must sometimes be completed without a detailed understanding of their need or importance sometimes causes dissatisfaction among SMEs. This is particularly true when the SMEs are fairly senior and the tasks are somewhat mundane or administrative in nature. An effort must be consciously made early in the selection process and to assigned SMEs directly to advise them about the nature of all of their prospective duties for a project.

On Balance

SMEs are a valuable ingredient for the team charged with the conduct of an OA project. They are virtually essential to the inventory development and data interpretation processes using any OA method; however, they are indispensable when dealing with the broader issues of employment, training, and career patterns during occupational structure evaluation. The size of the team can be problematic; so, "smaller is best," provided most of the basic MOC jobs can be covered with the SMEs' expertise. Part-time SMEs and working groups can always be imported to fill any gaps in the expertise of the team SME(s) and to validate job inventories before field survey.

Conclusions

Commanders and personnel proponents at all levels are demanding an ever-increasing amount of job-related information to promote or sustain proactive personnel systems. In addition, the military services are currently experiencing unprecedented change, with new roles and taskings. New ways must be developed for improving upon OA processes using the TI/CODAP methodology if military occupational analysis/survey programs are to keep pace with such change. It is the considered opinion of the authors that the team concept utilizing resident SMEs is one such improvement and is a most efficient way of meeting broad OA mandates such as those now being experienced by the Canadian Forces.

IV. A STUDY OF OCCUPATIONAL ANALYSIS PRACTITIONERS

John Fugill
Johnny Weissmuller
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The Network of Occupational Analysts (NOA) of Australia created and distributed a job inventory for CODAP practitioners--people involved in occupational analysis (OA) projects using the Comprehensive Occupational Data Analysis Programs (CODAP) software and methodology. Responses were solicited from practitioners worldwide during the summer of 1991. This chapter provides a broad overview of the results of this study. Copies of the complete report are available from the Institute for Job and Occupational Analysis (IJOA), 926 Toepperwein Road, Converse, TX, 78109.

The Survey Instrument

The survey instrument, dated May 1991, contained a Background Section and seven major lists. The Background Section solicited name; business telephone number; business address; type of employer (commerce, military, education, etc.); employer class (military, civilian); country of employment (Australia, Canada, or U. S.); job interest; use of abilities; use of training; organization use of language translations, Braille, confidentiality agreements, and security regulations; percent of data automation that is keypunch/keydisk or optical scanner or reader; and percent of projects that involve employer associations, managers in commercial firms, military organizations, non-military government departments, and unions.

The major lists included a "check all that apply" instruction for items under the following topics: "In what areas do you think more CODAP research is needed?"; "In what areas would you like procedural guides to be developed or improved?"; "In what application areas have you been involved during the past 3 years?"; "In what industries or sectors have you been doing occupational analysis work during the last 3 years?"; "How did you learn to do CODAP work?"; "What tasks do you perform in your current job?" (then rate relative time spent on a 9-point scale); and finally, "What knowledge items do you use in your current job?" The "Areas of Research" list had 20 items and ranged from "Abilities Inventories" to "Veracity of Survey Responses." The "Procedural Guides" list had 7 items and ranged from "Inventory Development" to "Survey Analysis." The "Application Areas of OA" list had 39 items and ranged from "Affirmative Action" to "Working Conditions." The "How I Learned CODAP" list had 5 items ranging from "Accredited University or College Course" to "Self-Instruction" (+ "Other"). The "Task" list had 113 tasks organized under 12 Duty Areas. The "Knowledge" list had 80 items ranging from "Analysis of Variance" to "Worker Characteristics."

The Current Data Base

Data were received and automated from 90 CODAP practitioners. With one exception, survey booklets from identifiable agencies were assigned consecutive Case Control Numbers (CCNs).

The diversity and representativeness of the sample are reflected in the following breakdown by booklet numbers. Booklets from Australia are CCNs 0001 through 0027 (and 0090); booklets from Canada are numbered 0028-0036; booklets from the United States Coast Guard are numbered 0037-0040; booklets from the United States Navy are numbered 0041-0050; booklets from the USAF Occupational Measurement Squadron are numbered 0051-0081; booklets from the USAF Armstrong Laboratory, Human Resources Directorate are numbered 0082-0085; and booklets from U. S. contractors are numbered 0085-0089. It is hoped that in the future other agencies may wish to complete this survey. With the atCODAP system used in this project, new data can be easily compared to and integrated into this data base.

The Job-Typing Results

Table 1 shows the 11 job types included in the Job-Type Diagram.

Table 1

Job Types in Job-Type Diagram

Reporting Cluster (Grp 21)	General Practitioner (Grp 45) Analyst (Grp 50) Report Writer/Presenter (Grp 49) Report Presenter (Grp 32)
Analysis Design Cluster (Grp 15)	Analysis Method Designer (Grp 37) Software Designer (Grp 54)
Independent Job Types	Supervisor/Manager (Grp 40) Survey Materials Writer (Grp 35) Inventory Editor (Grp 22) Data Entry Clerk (Grp 17) Completed Booklets Recorder (Grp 14)

Figure 5 shows the Job-Type Diagram for identified groups. Table 2 shows the task co-performance modules that were derived from this data set using standard procedures.

Because this inventory was well designed, had a small number of respondents (n = 90), a small number of tasks (n = 113) and a diversity of jobs covered (Data Entry through Executive), the experimental enhancements for task clustering did not noticeably improve upon the clusters found using existing methods. Those enhancements will be discussed in future papers on data sets requiring improved resolution.

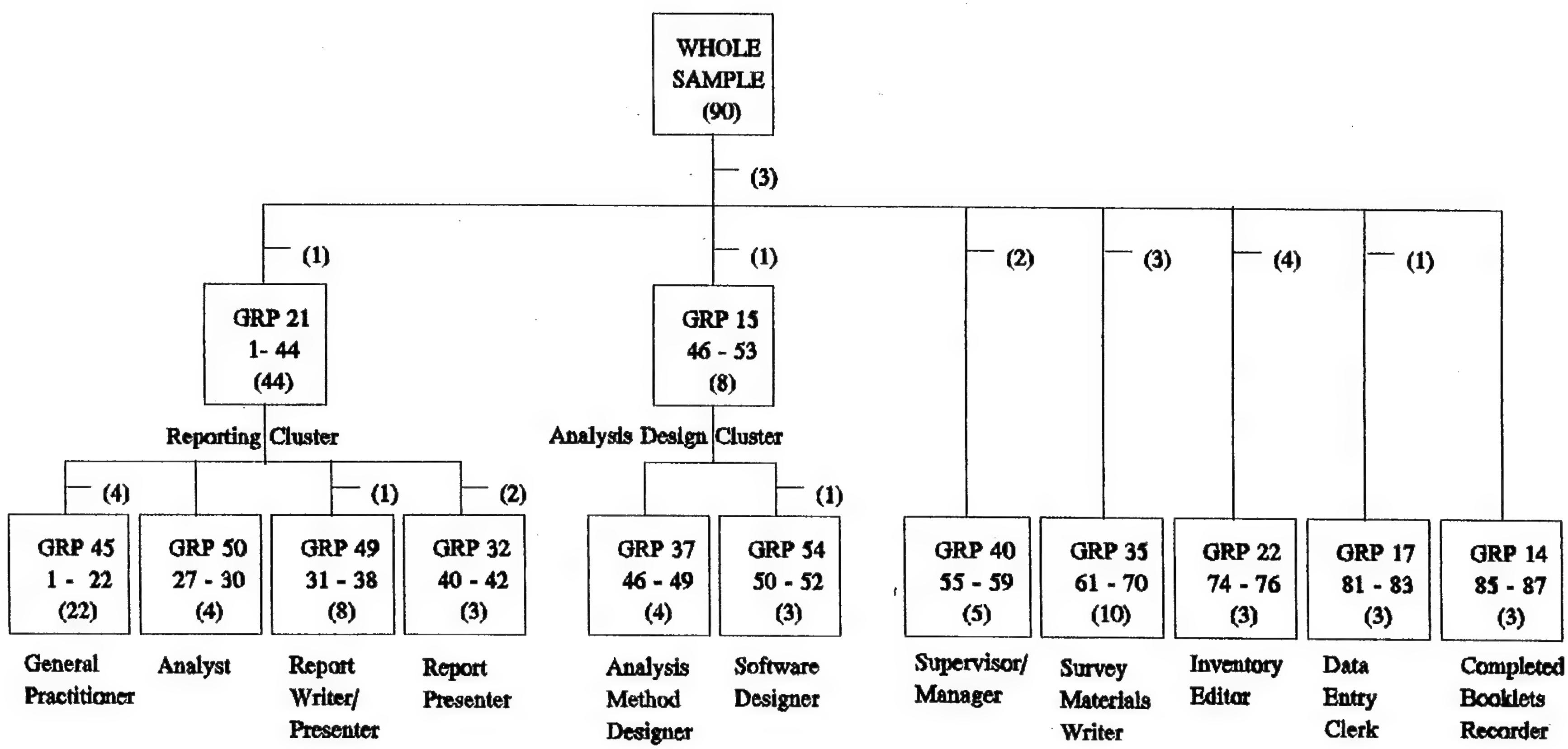

Figure 5. Job-type diagram for CODAP practitioners.

Table 2

Task Co-Performance Modules: CODAP Practitioners

Module No.	Module Title	Task Statements
1	Software Development-A	Calculate expected outcomes by hand Confer with analyst on requested new software Determine adequacy of existing software for proposed applications Develop specifications for new programs Decide whether to modify existing software or develop new software
2	Software Development-B	Establish prototype control cards or control specifications to exercise program options Identify file types required to accomplish objectives Test entire program for functions Test modules for functions
3	Project Management-A	Define objectives of project Advise managers on occupational analysis procedures Estimate project costs Monitor project costs
4	Project Management-B	Draft work program or schedule Gather information about client's requirements Estimate computing requirements Estimate keypunching or scanning requirements
5	Project Management-C	Define communication line or protocols Chair project meeting Convene project meeting Assign priorities or tasks Explain objectives, policy or practices Set standards or performance objectives
6	Project Management-D	Maintain staff roster Supervise survey data analysts Supervise inventory developers Supervise survey administrators

(table continues)

Table 2

Task Co-Performance Modules: CODAP Practitioners

Module No.	Module Title	Task Statements
7	Project Management-E	Define ownership of survey information Evaluate bidders' proposals Monitor technical performance of contract Draft contract
8	Survey Materials -Preparation	Identify sample of persons for interviews Conduct face-to-face interview with subject specialist Write Background Information section Develop preliminary inventory from source materials Write supplementary list (knowledge, tools, machines) Write survey instructions Conduct face-to-face interview with job incumbents Identify functional areas Organize schedule of interviews Translate interview notes into task statements Write up notes after interview
9	Survey Materials -Editing	Arrange task statements or other items into lists Edit Background Information section Edit task inventory Edit supplementary list (knowledge, tools, machines)
10	Report Writing & Presenting	Assign titles to job-type groups Identify job types Select groups of incumbents for whom job descriptions are required Interpret task factor data Write occupational analysis report Specify control values for computer runs Write work request for computer analyst Edit report to agreed reading level Correct errors or anomalies in report Answer client's questions about report Explain interpretation of computer printouts Prepare oral presentation Present oral report Rehearse oral presentation

(table continues)

Table 2

Task Co-Performance Modules: CODAP Practitioners

Module No.	Module Title	Task Statements
11	Field Surveying-A	Explain field survey procedures Prepare oral briefing for survey respondents Supervise booklet completion by expert panelists Supervise booklet completion by job incumbents
12	Field Surveying-B	Check accuracy of completed booklets Collate materials for mailing out Maintain records of returned survey materials Record survey responses by hand
13	Survey Materials -Formatting and Data Entry	Prepare artwork or layout of survey materials Enter survey responses into word processor or computer Implement data entry checking systems and procedures Type inventories or instructions

V. AN OPERATIONAL TEST OF OA AND TIDES DATA FOR MPT DECISION-MAKING

Major Randy Agee
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The Armstrong Laboratory/Human Resources Directorate (AL/HR) conducted an operational test of the Training Impact Decision System (TIDES; previously the Training Decisions System) in conjunction with a contracting team led by McDonnell Douglas Aerospace. Occupational analysis (OA) expertise and operational support were provided by the Occupational Measurement Squadron (USAFOMS). Plans for this test were reported at the Seventh International Occupational Analysts Workshop (Mitchell, Vaughan, Knight, Buckenmyer, & Bennett, 1991). Interim progress on the project was reported at the last two Military Testing Association conferences (Coccia, Mitchell, Knight, & Shrum, 1992; Mitchell, Buckenmyer, Huguley, & Knight, 1991).

Training Impact Decision System

TIDES is a computer-based decision support system specifically designed to support key decision-makers for a specialty at the HQ USAF and major command (MAJCOM) levels. The technology was developed to extend task-based job analysis to permit more systematic consideration of personnel utilization factors, training costs, resource requirements, capacities, and managers' preferences in determining the optimal allocation of training resources (Mitchell, Vaughan et al., 1992; Vaughan et al., 1989).

TIDES helps the Air Force functional and training communities balance a specialty's training needs versus resources and requirements to optimize career field management. The technology provides analysts and decision-makers with a tool to systematically gather, integrate, and analyze information about jobs, tasks, career field assignments, personnel flows, and the technical training system within an AFS. By dynamically modeling a specialty's career flow patterns, TIDES provides a "what-if" capability to assess the long-term impact of current and future constraints stemming from changing training and personnel policies and fiscal resources.

The basic functions performed by TIDES are analyses to help determine what tasks associated with a specialty to train, when to provide that training (i.e., to first-term airmen or second-term airmen), and in what setting the training should be provided. Currently, four training settings are assessed: formal classroom training including airman basic residence courses and supplemental training; supervised hands-on training such as is found in field training detachments (FTDs) and laboratories; self-paced study (i.e., correspondence courses or CDCs); and OJT.

The analysis approach begins with an assessment of the occupational survey report (OSR) information from USAFOMS. The OSR jobs are refined in TIDES by grouping individual task

data into task modules (TMs), which are the basic units of analyses in TIDES. TMs are developed through a CODAP clustering technique; tasks are reorganized into initial groupings based on co-performance as expressed in the occupational survey data. These initial groupings are then refined by subject-matter experts (SMEs) on the basis of shared skills and knowledges, and shared resources needed to train the tasks.

Use of TMs improves manageability by reducing the number of comparisons necessary from the 500 to 2,000 tasks characteristic of a job inventory to a smaller number of coherent groups of tasks. Use of TMs also reduces the possibility of overestimating training requirements, by reducing the redundancy associated with other means of task clustering.

Jobs are described in terms of TMs as are training courses and OJT requirements. TMs are also the basis for surveying selected personnel from the specialty to provide data on their individual job and training histories. This information helps analysts understand the flow of airmen from one job or training program to another within the specialty. TIDES analysts also survey technical training and FTD trainers to collect estimates of the time and resources required to train TMs in various settings. SMEs estimate airman proficiency on TMs as a function of time spent in training within the different settings.

The proficiency ratings result in the generation of allocation or learning curves. A task module allocation curve can be likened to the law of diminishing returns. It is a negatively accelerating curve based on a polynomial regression equation (Proficiency = # classroom hours - # classroom hrs^2) + (# CDC hours - # CDC hrs^2) + (# FTD hrs - # FTD hrs^2) + (# OJT hrs - # OJT hrs^2). Using TIDES, an analyst can determine the number of training hours (beyond those already expended in formal courses) needed to achieve 100% proficiency. For example, in Figure 6, if an airman receives 10 hours of training on a task module in the classroom, and 8 hours of training on that same module in an FTD, the curve shows that at the end of schoolhouse training, the airman is approximately 30% proficient on that task module; at the completion of FTD, the airman is about 36% proficient on that task module. Because the curves are additive, the airman is about 66% proficient after formal training. In order to make up the 34% deficit through OJT, the allocation curve indicates that about 7 hours are needed to raise proficiency to 100%.

TIDES integrates the information collected and identifies the current utilization and training pattern (U&TP) of a specialty. The U&TP is a qualitative and quantitative description of how airmen move through jobs and training throughout their careers. Figure 7 shows the types of jobs available at different points in a career, as well as the technical training and professional military education (PME) associated with these jobs. It also shows that as airmen flow through their careers, typically a variety of jobs are available to them as they increase skill level and experience. As shown in Figure 7, airmen enter Basic Military Training and then attend an airman basic residence technical school for their specialty. Following completion of technical training courses, airmen are assigned to one of several jobs. Associated with that job there may be other forms of technical training--an FTD or self-paced study such as a CDC.

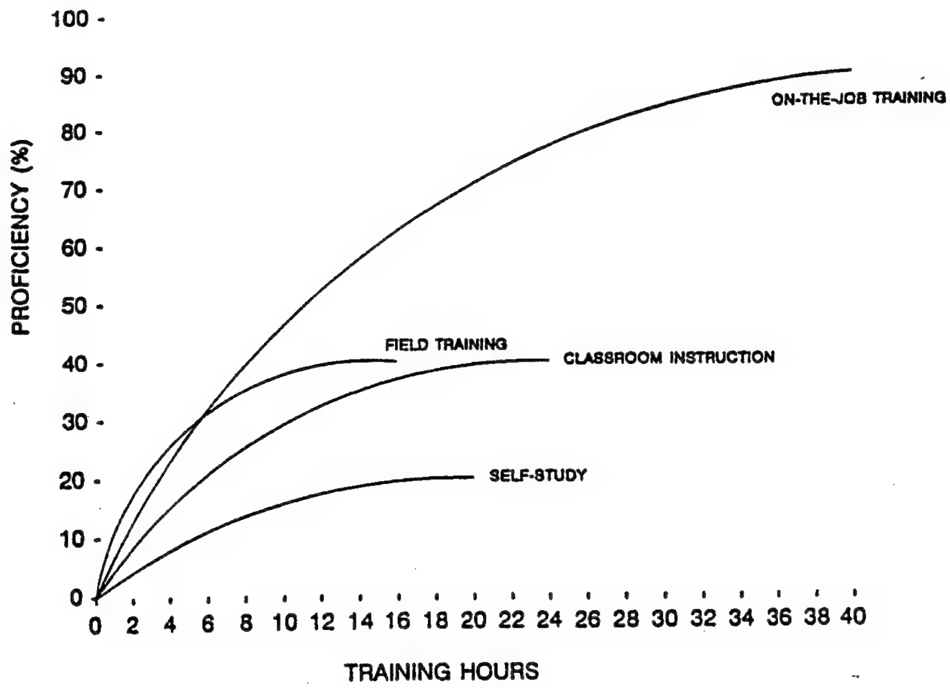

Figure 6. Example task module allocation curve.

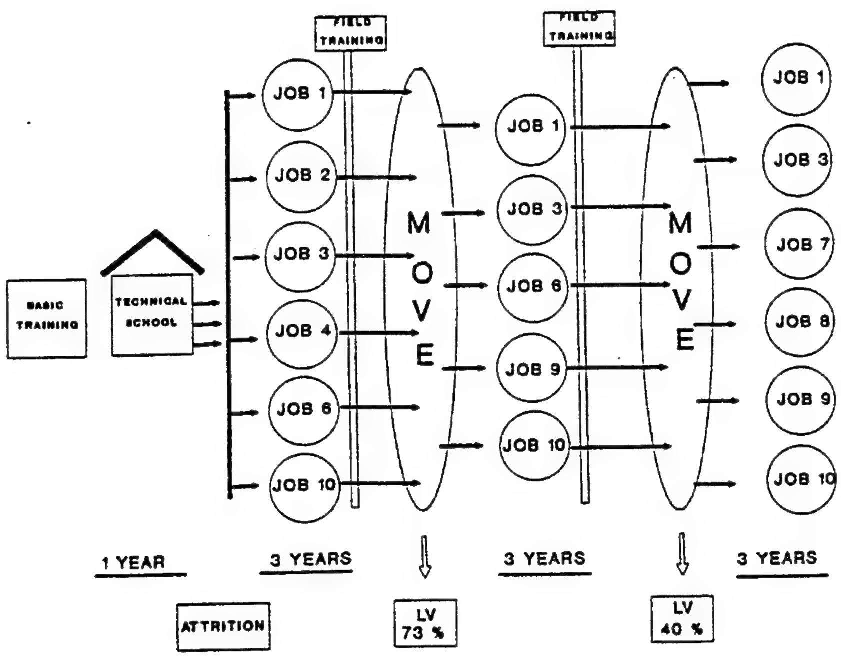

Figure 7. Example AFS Utilization and Training Pattern.

As in "the real Air Force," there is a probability associated with whether airmen will receive the formal training associated with the job to which they were assigned. After airmen complete their first assignment, they enter a collect pool in the TIDES model where they may be joined by cross-trainees from other specialties, exit the system via separation or cross-training, reenlist into the same job, or be assigned to a second assignment. Again, there are probabilities associated with being assigned to a particular job, and a further probability that technical training needed in that job will be provided. By assessing the thousands of airmen within a specialty and summing across all individuals flowing through the model to establish a steady state, we have found that this method of computer simulation can provide realistic and stable estimates of real-world requirements. Thus, by simulating the flow of airmen, along with their probabilities of receiving or not receiving training, the long-range impact on the mission, formal training, and OJT can be determined.

Figure 7 can be used to identify OJT requirements because any associated training not provided within the realm of technical training must be provided through OJT. Determining OJT costs and requirements is an area in which the Air Force has traditionally not been able to make many inroads. By using TIDES, functional managers can determine the relative cost of OJT in the form of salary of trainers and trainees, number of hours required to deliver training, and the cost of variable, expendable resources used in the training.

Once the current U&TP is established, it can be used as a baseline against which alternative patterns can be evaluated. Alternative utilization and training patterns are the means by which functional managers can perform what-if analyses, and evaluate proposed utilization changes prior to implementation, to determine the most effective combination of training factors and enable airmen to achieve full proficiency within available resources. Capacity analyses are performed to balance training requirements in terms of people, critical equipment, and mission against the current and projected available resources. One can also impose constraints on the modeling program to determine the amount of training and the content of training necessary to achieve a specified goal.

Using TIDES, decision-makers can assess how changes in such areas as budget, MPT policies, and job restructuring impact other factors such as training costs and capacities in terms of training drivers (i.e., number of trainers and trainees, availability of critical equipment or resources, and relative costs associated with personnel and resources). By providing the capability to assess proposed U&TPs prior to implementation, functional managers can maximize operational readiness, training effectiveness, and efficiency while minimizing training costs, yet still provide the means to produce the highest quality, fully trained forces.

Determination of the optimal allocation of training resources is made through accurate trade-off analyses of alternative training decisions; this what-if modeling capability is the hallmark of the TIDES technology. Examples of the types of analyses that can be performed for an AFS include:

- How can OJT resource capacity limitations be alleviated?

- What are the cost and capacity consequences of eliminating (or adding) a formal technical training course?

- How will increased student flow through the entry-level course affect training?

- What is the long-term impact of a 25% reduction in TDY-to-school costs on a specialty's mission?

- What is the optimal allocation of training tasks within a formal training course?

- Can we reduce costs by recruiting industry-trained people and then sending them to direct duty?

- Will shortening (or lengthening) reenlistment rates reduce costs and still provide sufficient AFS coverage?

- How will a change in travel and per diem costs or salary levels affect training costs?

TIDES empowers top-level decision-makers to determine optimal utilization of training resources. Such capabilities are essential if the Air Force is to plan the full use of limited resources and still achieve the readiness needed to implement Global Reach/Global Power.

The need for TIDES is highlighted by General McPeak's 1992 Year of Training objectives, many of which can be supported through implementation of the TIDES technology. Another factor pointing to the need for TIDES is our complex technical training system. There is a wealth of information pertinent to the resolution of MPT decisions, but each function within the Air Force has a small piece of the puzzle, and there is no consolidated data base which integrates the information into a form readable by the applicable users. TIDES complements other MPT technologies such as the Base Training System (BTS) in the integration of data.

Yet a third reason underscoring the importance of TIDES is the massive reorganization we are all experiencing. As specialties and MAJCOMs merge, we must make smarter training decisions. As part of that effort there is an increased emphasis on utilization and training workshops (U&TWs) and the role of the functional manager. With the elimination of Training Staff Officers in the Air Training Command, many of their responsibilities have shifted to the functional managers, including the responsibility for determining technical course content.

Functional managers have also been tasked with developing and implementing Career Field Education and Training Plans (CFETPs). These plans outline the flow of airmen through a specialty, including the points at which airmen should transition to new job assignments, receive technical training, and receive PME. The plans also outline training objectives for a specialty

and list the training opportunities available to personnel in that specialty. In our on-going research, we found that this is an area in which functional managers may have incomplete information. They may not be aware of many of the MAJCOM-provided and contractor-provided training programs. TIDES helps identify low-visibility courses.

Although functional managers have a full plate, their resources are limited; and it is anticipated that they will have to begin programming for training dollars in the near future. TIDES provides functional managers with the hard data and estimates they need to bolster their justifications for the funding needed to support their training objectives.

Operational Test

To test TIDES' ability to support functional managers and the demands of a U&TW, the TIDES technical team (consisting of members from AL/HR, USAFOMS, and contractors) has been working with the HQ USAF functional manager in the 305X4, Electronic and Computer Switching Systems, career field. This chapter presents an update to the paper presented at the previous International Occupational Analysts Workshop (Mitchell, Vaughan et al., 1991), which outlined the plan to utilize a U&TW as a test bed for assessing the effectiveness of TIDES.

To implement the test plan, the TIDES technical team met with the 305X4 HQ USAF functional manager to determine his needs; after several rounds of discussions, he identified several candidate scenarios for potential application to the 305X4 specialty and asked for analyses of each scenario. The alternatives modeled were

1. the current U&TP, with the existing seven shreds merging at the 5-skill level;

2. implementation of a common electronics principles (EP) course and elimination of all airman basic residence (ABR) courses;

3. the merger of all shreds into a single-ladder career field;

4. extending the existing shreds to the 7-skill level and providing separate ABRs for each;

5. reducing the number of shreds to three or four; and

6. reducing the number of shreds to three or four, extending the shreds to the 5-skill level and merging them at the 7-skill level.

To initiate the analyses for each scenario, USAFOMS data had to be assessed, and additional SME data had to be gathered. The contractors worked closely with the USAFOMS occupational analyst to determine the job structure and task clusters. They jointly developed the job typology reported in the OSR for the 305X4 specialty; this cooperation enhanced the overall analysis process.

To collect SME information, the R&D team hosted a preliminary TIDES data collection workshop. The functional manager selected the MAJCOM and training representatives and requested their participation in the 4-day meeting. With the functional manager in attendance, the contractors briefed TIDES and administered the TIDES surveys to the participants.

The senior 305X4 NCOs who assembled for the May 1992 workshop validated, titled, and refined the task modules originally created using the co-performance algorithm. The SMEs also provided judgments of time and resource requirements and determined proficiency ratings for each TM in each of the training settings. The final results grouped the original 657 occupational inventory tasks into 73 modules which can be characterized as follows:

largest module - 36 tasks

smallest module - 1 task (two of these; three modules contained 2 tasks)

most modules contained between 5 and 20 tasks

five obsolete modules

each module had a specific title reflecting the commonality of tasks

A majority of the 11 data collection workshop participants later attended the U&TW. This overlap greatly facilitated decision-making at the U&TW, because many of the attendants were already familiar with and had confidence in the data. Data and results of the analyses were presented at the formal 305X4 U&TW conducted in March 1993.

The first effort involved using TMs to determine commonality among the seven 3-skill-level-awarding technical schools (ABRs). Using the Plan of Instruction (POI) for each of the seven courses and the match that USAFOMS prepared (each inventory task was matched to a POI block of instruction), participants were able to approximate the number of hours devoted to each module in each course. The module grouping made a more comprehensive common denominator across all the functional areas of this AFS than the Specialty Training Standard (STS).

Rather than the traditional STS scrubdown that a U&TW would perform, the group chose to go through each module task by task using the expertise represented and determine the proper training setting for each of the tasks in the 73 modules. In this case, the training settings were defined as technical school/laboratory, self-paced, or OJT. Table 3 depicts several example modules as they were applied to the present courses in terms of hours spent in the technical training environment.

Using the TMs to compare across present courses and looking at present POIs, the group was quickly able to visualize the similarities and differences. Using their extensive knowledge of the career field's changing technology and present technical instruction, a new proposed training structure (initial skills, upgrade OJT, and advanced courses) was built using the task modules. Examples of the modules are shown in Table 4 with the proposed number of hours to be devoted to training in the new technical training environment

Table 3

Present Courses - AFS 305X4

		E SHRED	L SHRED	R SHRED	T SHRED	M SHRED
2	PERFORM GENERAL MAINTENANCE	13.5	60	51	54	47.5
3	MAINTAIN DISC SYSTEMS	6	26	41	0	32
4	MAINTAIN PRINTERS	0	22	12	28.5	25
5	MAINTAIN DISPLAY EQUIPMENT	25.5	11.5	7	33	178
6	MAINTAIN MAGNETIC TAPE UNITS	10	0	21.5	25.5	16
7	CONSOLE AND OPERATOR PANEL MAINT	0	25	16	3	22
8	PROCESSOR & MEMORY ASSEMBLIES MAINT	46.5	54	77.5	26.5	209
9	POWER SUPPLY MAINTENANCE	7	27.5	13.5	0	0
10	BENCH CHECK ASSEMBLIES	0	9.5	7.5	23	0
.	.	.	.	.	.	
.	.	.	.	.	.	

Table 4

Proposed Courses - AFS 305X4

		COMMON	A SHRED	B SHRED	C SHRED
2	PERFORM GENERAL MAINTENANCE	18	119.5	1	62
3	MAINTAIN DISC SYSTEMS	18	19.5		27
4	MAINTAIN PRINTERS	18		1	23
5	MAINTAIN DISPLAY EQUIPMENT	38	64.5	2	13
6	MAINTAIN MAGNETIC TAPE UNITS	18	14	2	
7	CONSOLE AND OPERATOR PANEL MAINT		22	6	26
8	PROCESSOR & MEMORY ASSEMBLIES MAINT	58	29.5	2	55
9	POWER SUPPLY MAINTENANCE	19		1	28
10	BENCH CHECK ASSEMBLIES				
11	TROUBLESHOOT TO COMPONENT LEVEL	102	58.5	135	
.		.	.	.	.
.		.	.	.	.

Based on TIDES input, the existing seven shreds of the 305X4 specialty were restructured to three shreds which merge at the 7-skill level. This streamlining will reduce costs, improve training, and enhance assignment and promotion opportunities for the career field.

Throughout the workshop, the contracting team was available to perform near-real-time analyses. For example, when the U&TW participants needed additional shred data to augment their specialty restructuring task, the contractors presented the information the following morning.

Also, when the functional manager requested data on the effects of increasing the average time on station to 48 months, the next morning the contractors reported their analyses which indicated a substantial reduction in required OJT.

Evaluation

At the completion of the U&TW, the TIDES team solicited feedback on the utility of TIDES to the decision-making process. Participants were asked to rate such items as how accurately the current U&TP reflected the specialty; how much the data from the alternative U&TPs aided specialty restructuring; how much TIDES analyses contributed to training allocation; and how much TIDES data helped in estimating OJT requirements. Participants were also asked to suggest additional types of information that might have been helpful.

The AFS 305X4 workshop was held at an R&D base and the logistics of the meeting were handled by AL/HR and USAFOMS to provide ready access to OSR and TIDES data bases. This location proved very useful in that participants were isolated from normal operational pressures. Future U&TWs may be much more fruitful if they are held at off-site locations, with logistics and arrangements handled by a hosting organization.

The biggest lesson learned involved the need for complete data collection. Once an SME body is assembled, it is imperative that all needed data be obtained by that time. It is very difficult to complete data files after a group has returned to their normal operational duties and locations and must be contacted by phone or mail.

All of the 22 MAJCOM and training participants found the TIDES data to be useful and accurate in the representation of the 305X4 specialty, and all but one wholeheartedly recommended including TIDES analyses for other specialties in future U&TWs. Participants stated that the what-if analyses greatly facilitated their difficult task of redefining the structure of the specialty. Respondents further reported that TIDES data provided an excellent means for conveying complex information. Eighty-two percent (82%) reported that the TIDES data were excellent or above average in complementing the USAFOMS data traditionally presented at U&TWs. Ninety-five percent (95%) reported an enhanced ability to determine skill-awarding-course content, and eighty-six percent (86%) reported an improved ability to allocate training. Eighty-two percent (82%) stated that TIDES data greatly helped to estimate OJT requirements, and seventy-three percent (73%) cited an improved means to determine resource requirements.

As a result of the highly successful integration of USAFOMS data and TIDES data, the functional manager is interested in pursuing similar support for the other specialties he manages.

In a 20 April 1993 letter to HQ ATC/TT on "Use of the Training Impact Decision System (TIDES)," Brigadier General William M. Douglass, Director of Maintenance, HQ USAF/LGM, noted, "This is the first time TIDES was used as part of a U&TW and the success of the U&TW is due largely to its use." He went on to say, "We are excited about this technology and look forward to expanding its use to additional maintenance specialties."

AL/HR and the contractors are providing continued support to the functional manager. Post-U&TW activities will consist of additional modeling of newly defined scenarios. Additional data collection and analysis will continue, as another meeting of this group is tentatively scheduled for late fall of this year. One analysis was completed which had to do with the functional manager's concern over the possible loss of FTD training.

Three scenarios were constructed based on this concern:

1. Total loss of follow-on training after technical school completion--no 5-level or 7-level or equipment-enhancement courses. (The only courses available would be the basic ABR and four PME programs.)

2. Loss of Field Training Detachment support. (This means all the generic FTD courses, such as Technical Orders and soldering, and, more importantly, the specific FTD 305X4 courses taught at Tinker and Offutt AFBs.)

3. Loss of all technical school follow-on and enroute 5/7-level training. (FTD training would continue as is.)

[Note: *PME and the basic ABR would remain the same in all scenarios*.]

All of the above scenarios have since been modeled and results made available to the functional manager.

The newly proposed C shred is actually a merger of the old L (SACDIN) shred and the Missile Communications Specialty (AFS 362X3). To aid in this endeavor, the contractor task clustered past occupational survey data. These data are presently being matched to 362X3 POI blocks necessary for inclusion in the newly proposed C-shred course. Of the 362X3 task modules, it appears that only six or so need to be included in the newly identified career field. Work is continuing in refining these courses.

Summary

The operational test was highly successful. TIDES can be used to dynamically model the long-term personnel and training issue impacts on an AFS for various combinations of training content, sites, and proposed policy changes within the training system. TIDES is a powerful methodology to aid key decision-makers at the MAJCOM and USAF levels in determining the

optimal utilization of resources necessary to support the mission of an AFS. Some of the expected benefits of TIDES are as follows:

- Career field planning/management support tool.

- Training cost forecasting model, including OJT cost estimates.

- Simulation and evaluation of current and alternate AFS utilization and training patterns.

- Data support for U&TWs.

- Integration of comprehensive MPT information into a single data base for each AFS.

- MPT decision impact assessment capability in terms of costs, resource requirements, and training system capacities.

TIDES has been involved in several previous U&TWs, including the Security Police (811XX), B-1 Avionics Test Station (AFS 451X7), and Aerospace Propulsion (454X0A/B). However, the entire scope of the TIDES program was not yet available to the participants at the previous workshops during the initial R&D. The AFS 305X4 U&TW used the full robustness of the TIDES programs to look at all issues in the MPT arena (classification structure, training equipment needed, training costs, unit capabilities, etc.). Particularly revolutionary was the fact that task modules were used rather than the standard STS. Task modules simplified the complex requirements of this diverse specialty and helped participants deal directly with relevant behavioral objectives. Senior managers were able to view their career field from different perspectives when the many varying "career path" scenarios were modeled. Furthermore, task modules were used to construct general content for the technical ABR courses.

VI. MILITARY OCCUPATIONAL ANALYSIS: FUTURE DIRECTIONS

Winston Bennett, Jr.
David S. Vaughan
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Occupational or job analysis provides a detailed specification of the requirements for performance within jobs (Cascio, 1991). The previous chapters have served to highlight uses of occupational analysis information within the military context. In addition, job or occupational analysis data are used for personnel recruitment, selection, placement, training and development, and performance appraisal (Cascio, 1991; Muchinsky, 1990). Typically, job analysis data are used to portray the current state of tasks within jobs in an organization for these purposes.

We believe that there are key areas of opportunity for future research in occupational analysis and application. These include improvements to existing OA practice and extending OA applications for multilevel analysis and dynamic organizational modeling. Each of these areas will be discussed in the following sections.

Improving Current OA Practice

Currently, the practice of OA--conducting OA studies and applying OA results--is a very costly, labor-intensive activity. A great deal of time and effort is required, for example, to build a task inventory, administer and process the various surveys based on the inventory, analyze the data, and use the results for MPT planning and decision-making. The time required for job incumbents and SMEs to complete surveys, in the aggregate, is quite large. Also, a great deal of time and effort is required to train occupational analysts and support staff. One significant future direction for OA lies in improving current practice so as to obtain better and more widely used results with less cost and effort. Current OA practice can be improved in several ways, including (a) improved task inventory development processes; (b) developing and implementing advanced automated tools for OA analysis; (c) developing automated, adaptive survey administration; (d) improving rating response scaling methods; and (e) developing software user interfaces.

Improved Task Inventory Development

The starting point for task-based OA is the task inventory. The overall value of an OA study is critically dependent on the quality of its task list. However, task list development is probably the least systematically studied aspect of existing OA technology. We believe that a major focus for OA-related R&D should be task inventory development. We also believe that this work should consider the particular issues to be addressed using the inventory. There has been significant progress in this area. For example, Driskill, Gorman, Weissmuller, Tucker, and Hand (1992) have developed methods for constructing task inventories from logistics-related data sources for aircraft maintenance occupations. This approach ensures that the task inventory reflects major aircraft subsystem differences and is consistent with the way in which the target

occupations view their work, while reducing the effort and subjective judgment required to build a task inventory. We believe that this kind of R&D should be continued and extended to a broader occupation range, and be implemented as appropriate.

Advanced Automated Tools for Occupational Analysis

Even with adequate computer support for the creation of statistical results and summaries of OA data (e.g., CODAP), the analysis process is very labor-intensive. A major portion of the analysis effort is devoted to interpretation of statistical cluster analysis for job typing and task clustering (task module development). Also, a great deal of training is required for one to be a successful analyst. One step that has been taken to reduce both the labor required for analysis and the training required is to standardize the analysis process. A standard set of computer products are produced, and interpreted and reported in a standardized way. A disadvantage of this approach is that specific, unique questions and issues in a particular occupation may not be addressed by the standard analysis. Therefore, the users' needs may not be effectively met.

Advanced automated analysis tools could reduce the overall effort required for analysis and aid in tailoring analyses to better meet users' needs. Substantive work is underway to use automated tools for job typing and task clustering (see Chapter II). To date, this work has been quite successful. However, more progress can and should be made in automated job typing and task clustering. For example, tools should be created for addressing specific user questions and issues. These tools could be used to interactively present a wide variety of examples of questions and analysis products and procedures to address specific types of questions. Further, these tools could be integrated into an interactive computer program (perhaps a "front end" to CODAP) that gathers information from an analyst or a user concerning questions and issues to be addressed and then provides advice concerning what analyses to conduct and what reports to request.

Similarly, artificial intelligence (AI) researchers have made great strides in the development of rule-based computer algorithms that capture expert performance on tasks and related analysis activities. These algorithms might be used to develop programs to accomplish many of the activities now done by analysts, thereby reducing the time and costs associated with inventory development and routine data analysis. However, these AI approaches have not been applied to the task-based occupational analysis approach. Further, initial studies have been conducted to demonstrate the utility of computer-based inventory data collection programs (see Chapter II). However, research to determine the effectiveness of these programs for large-scale data collection needs to be conducted. This research would be concerned not only with the efficiency and cost-effectiveness of the programs, but also with the impact of the programs upon the quality of the data (e.g., reliability and validity).

Automated Adaptive Survey Administration

As suggested above, survey administration and processing require a great deal of time and energy, from both the occupational analyst (to create and administer surveys and to enter and

process the data) and the respondents (to complete the surveys). Today, desk-top computers are widespread in the Air Force. Furthermore, current Air Force projects such as the Base Training System (BTS; O'Connor, 1990) are introducing the use of computers at the work site, with supervisors, for MPT management. The availability of computers facilitates the administration and processing of OA surveys by computer, rather than by paper-and-pencil. In addition, such computer-based survey administration would avoid the need for paper reproduction of surveys, mailing and handling, and entering data into the computer. Such surveys could also be adaptive (i.e., presenting a respondent with subsets of the overall task inventory appropriate for that particular respondent). This would reduce the respondents' workload, which could both save time and improve data quality. Presently, work is underway to create automated OA surveys (see Chapter II). Results from this work should be implemented as appropriate.

Response Scaling

Significant improvement in the reliability and validity of OA rating data is expected to result from research being conducted by Phalen (see Chapter II). This work should result in more realistic estimates of <u>real</u> time spent in Air Force work activities. These estimates will be directly useful for manpower determinations and management engineering studies.

Under current OA practice, task time spent ratings are gathered from respondents on a relative rating scale. These ratings are linearly rescaled for analysis. A great deal of research has been done on psychophysical scaling (scaling subjective perceptions of objective physical characteristics, such as length, weight, and sound intensity). A general finding of such psychophysical scaling research has been that subjective perceived magnitude is logarithmically related to associated physical scale values. These results suggest that subjective time spent ratings may not be linearly related to actual time spent. These results also suggest that other approaches to gathering subjective time spent ratings may produce more accurate estimates of actual time spent than does the relative rating scale currently used. We believe that the issue of how best to gather time spent ratings and estimate actual times from these data deserves research attention. In fact, such research is on-going (see Chapter II). Such work should be continued and implemented as appropriate.

Current OA practice involves gathering, in addition to time spent data, subjective ratings of task factors from SMEs (e.g., task learning difficulty, recommended training emphasis). Though many of these task factors are less clearly related to underlying physical variables, we believe that response scaling issues should be examined for these task factor ratings. Psychophysical scaling approaches might be useful for some task factors (e.g., strength and stamina, hazard potential). Another approach that might improve both task factor and time spent scaling involves better establishment of the context within which incumbents/SMEs provide ratings. Basic research related to the nature of time spent ratings and the rating context necessary to ensure validity should be conducted.

Software User Interfaces

The CODAP software system (Christal & Weissmuller, 1988) has proven to be an extremely powerful tool for OA. Research and application activities have continued to add analysis features and capabilities, such as automated aids for job typing and task clustering, as well as to rehost the software to operate on computer systems available to the military OA users. However, the user interface for CODAP is a batch-processing-oriented design that requires significant training and experience, both with CODAP and with the host computer operating system. Given the batch-mainframe origins of CODAP, this is very understandable. However, today's computer hardware and software technologies offer the possibility of a much more user-friendly, interactive user interface. Such an interface should be developed for CODAP. This interface would significantly reduce the training and effort required to use CODAP. Also, the interface could assist in creating computer products to address specific users' questions and issues. CODAP is currently being rehosted to operate on IBM RS6000 computers running a variant of the UNIX operating system. This rehosting will greatly facilitate creation of an interactive, user-friendly interface, because many tools for such interfaces are available under the UNIX operating system such as the XWINDOWS and MOTIF graphical user interface software and tools for building such interfaces. Research exploring the costs and benefits of several interface approaches should be conducted.

New Occupational Analysis Applications

Occupational analysis data are potentially useful for many human resources/MPT management purposes. Historically, OA data have been used in the Department of Defense for classification structure determination and training planning purposes (see Chapter V). In the future, OA results should be extended for application in other important MPT areas. These areas of potential application include organizational right-sizing, organizational change evaluation, establishing physical and aptitude requirements for occupations, determining assignments, establishing and evaluating personnel policies, and reducing work-related accidents.

Occupational analysis methods have been explored in such areas as the development and validation of a hazard potential task factor (Thompson & Ruck, 1978). This hazard potential task factor could be useful in identifying tasks for attention (e.g., training or job redesign) for reduction of accidents. Similarly, Weeks (1984) and Gott (1981) have developed task-based methods for determining aptitude requirements and physical task performance requirements, respectively.

Potentially valuable new applications of OA data exist in the manpower and personnel policy areas as well. The various services have analysis methods and tools in these areas. For example, the Air Force uses the Enlisted Force Management System (EFMS), a system of mathematical models, to support planning and decision-making relating to manpower, force structure, and personnel policy issues. For example, the EFMS is used to predict the future Air Force-wide numbers of airmen at various grade and years-of-service levels and to investigate various ways of making that expected structure more nearly match the objective structure (the

structure that should exist, given Congressional constraints on authorizations by grade, etc.). The EFMS predicts a variety of Air Force-wide and occupation-specific outcome variables, based on many manpower and personnel parameters. These input parameters, or predictor variables, are estimated from various existing Air Force manpower and personnel data files.

OA data currently have no role in the EFMS or in other Air Force macro-level MPT planning and analysis models, yet the use of OA data has the potential to significantly enhance such models, both in terms of accuracy and in terms of richness and usefulness of outputs. For example, in the EFMS, real variation within jobs and occupations, as well as between occupations, is ignored or assumed away. That is, the impacts of such simplifying assumptions on the model outputs remain untenable. Furthermore, systematic consideration of such occupation and job characteristics would permit different policies and procedures to be used, which, in turn, would permit more effective management of the various occupations while better meeting overall force constraints.

We also recommend that significant additional issues within the classification structure and training areas be addressed by OA technology. In classification structure, for example, current OA data have proven very useful for examining single occupations or small sets of closely related occupations (e.g., the two Air Force Security Police occupations). However, OA data are less useful for addressing broader occupational structure/specialty structure issues. Current OA practice provides little assistance in determining the best way to structure work in a broad area, such as all Air Force aircraft maintenance jobs.

Similarly, OA data have proven very useful for training planning purposes. However, significant training issues remain unaddressed by OA technology. Results from Ruck et al. (1987) support prioritizing tasks for training for a specified target population (i.e., first-term airmen). However, those results provide only indirect support for allocating task training to formal technical schools, correspondence courses, OJT, or other training delivery locations and methods. The fundamental drivers of these training allocation decisions relate to overall training costs and resource constraints. Furthermore, overall training costs and resource constraints are influenced by many non-training factors such as job structures, personnel assignment policies, geographic location/dispersion, organization manning, and the availability of equipment, among others (Mitchell et al., 1993).

Conventional approaches to studying training impacts on organizations would relate training directly to organizational productivity. This approach has been attempted in conventional training utility analysis studies (Cascio, 1989; Mathieu & Leonard, 1987). However, relating training to overall organizational productivity can be difficult. In noncommercial settings, such as the Air Force, it can be difficult even to define the theoretical organizational productivity construct in a way that is applicable to entire occupations (Bennett, Ruck, & Huffcutt, 1992). In a recent organizational modeling study (see Vaughan et al., 1989), this problem was avoided by fixing organizational productivity at a constant level and then estimating training resource requirements, costs, and capacities required to achieve the fixed productivity for various training scenarios. In this way, the influence of training on meaningful organizational variables (e.g.,

operating budgets and resource requirements) is estimated, permitting identification of the least expensive way of meeting training requirements that is consistent with training resource availability constraints.

Improved OA Technology for Applications

Occupational analysis, as currently practiced in the military, typically involves obtaining task-level information concerning people performing such tasks (e.g., percent members performing and percent time spent) and concerning task factors (e.g., task learning difficulty, recommended training emphasis). Such task-level summary statistics are used directly or are summarized into other task-level indexes (e.g., the Automated Training Index) or job/occupation-level summary statistics (e.g., job difficulty). In the future, the use of more sophisticated approaches for using OA data to support MPT planning and decision-making can greatly improve the usefulness of OA data for such purposes. Moreover, several of the new applications discussed above (e.g., organizational right-sizing and organizational change evaluation) will require much more sophisticated approaches and improved approaches to data collection and analysis.

A Common Framework for Analysis

Another key issue in occupational analysis is related to the development of a common framework for analysis. Specifically, although the purposes for using occupational analysis data may vary, the methods and the units of analysis should share a common basis. This common basis would facilitate the generalizability of findings and models from one situation to another. Ideally, a single, multipurpose analysis method could be developed and applied in a variety of settings and for a variety of purposes. Future research should focus on the development of common analysis methods encompassing multiple levels of analysis.

Aggregating Task-Level Information

One area in which improvements are required to better support application of OA results to MPT planning and decision-making is in obtaining and relating OA results at multiple levels of analysis. This is particularly important for addressing organizational right-sizing and change evaluation, because both individual- and organizational-level variables are important for addressing such issues.

Though detailed task-level information is critical for certain uses, such as training development or selecting topics for promotion tests, such data may be too complex and specific for other purposes (e.g., to facilitate management macro-level decision-making or evaluating the possible impacts of organizational restructuring). Organizing task information into task modules, jobs, and higher-order categories allows the data to be applied to more global issues and problems and can be used to develop realistic models or simulations of occupational structures and requirements. Several task characteristics may be used to group tasks into more meaningful groups. These characteristics include grouping by equipment used, by function, and by task co-performance.

Task clustering using co-performance values as a basis for developing task modules (TMs) has been demonstrated in several recent applications (see Mitchell, Phalen, & Hand, 1991; Perrin et al., 1988; Vaughan et al., 1989). Task co-performance is defined as a measure of the similarity of pairs of task profiles across all the people in an occupational survey sample. For details of the computation of measures of task co-performance, see Rue et al. (1992).

TM-level data can be used to provide very concise descriptions with which to compare jobs within a specialty. For example, jobs can be described by TM-level information which is based upon average time spent across the tasks within each module and percent members performing data which are average values across the tasks within each module. This provides comparable statistics for the TMs. It is much easier to compare such TM-level job descriptions for various jobs within a specialty than it is to analyze task-level job descriptions (typically ordered on descending percent time spent or percent members performing). Thus, a modular approach provides a structured, summarized set of data which facilitates between- or within-job comparisons.

From Static Descriptions to Dynamic Modeling

A second improvement is related to modeling and prediction. For more complex decision-making situations, the process of extrapolating from an OA description of the current situation to what might happen under various alternative future events becomes problematic. Systematic modeling/prediction methods can provide effective solutions to these OA application problems.

The primary focus in military OA research and development has been on obtaining the most detailed and accurate description of the current situation (tasks, jobs, etc.) in an occupation or organization. For example, a great deal of effort has been devoted to refining methods for identifying current jobs (e.g., job typing) and task characteristics (e.g., task factors, such as task difficulty). However, uses of OA data usually involve making predictions about other variables in the future (possibly under various alternative scenarios). A good, accurate picture of the current job and task requirements is an essential starting point for such prediction. Typically, when OA data are used to support MPT planning, these predictions are only informally and implicitly related to the current baseline OA data. The usefulness of OA data could be greatly increased by developing explicit models for using OA data, along with other relevant data, to predict future organizational outcome variables of interest for MPT planning.

This is not to say that modeling has been excluded from OA R&D. For example, a great deal of attention has been given in several OA methodologies to modeling for compensation purposes. Here, the modeling typically involves predicting current salaries for job incumbents from OA-based data on incumbents' jobs. Similarly, modeling has played a key role in validating OA task factors such as recommended training emphasis (Ruck et al., 1987), task hazard potential (Thompson & Ruck, 1978), and job difficulty (Weeks, 1984). However, such modeling efforts have focused on a single criterion variable and have been relatively restricted in the predictor variables considered.

Organizational-level variables have typically not been included as either predictors or outcome variables (see Bennett et al., 1992). Several new OA applications require predictions concerning organizational-level outcome variables under various alternative organizational structure/change scenarios. This is true for both organizational right-sizing and organizational change evaluation applications. Such organization-level prediction is also required for many manpower and personnel policy issues.

In order to provide analytic support for applications such as these, as well as to better support existing applications (e.g., occupational structuring and training needs assessment), OA technology should be extended to dynamic modeling of organizations. As described above, the EFMS is such an organizational-level estimation or prediction model. Here, the principal R&D issues concern how to best incorporate OA data to refine the EFMS models. For other MPT planning applications, no macro-level models exist comparable to the EFMS. In these cases, organizational outcomes of various policy outcomes (e.g., overall productivity, cost, degree to which resource constraints can be met) must currently be estimated by planners from the existing baseline OA data. Therefore, OA-based models related to these applications will need to be developed from scratch.

The Training Decisions System: An OA Modeling Case Study

How might such a model be built? One approach is to estimate all model parameters simultaneously from a single set of data using a latent variable structural equation modeling procedure (e.g., Loehlin, 1987). However, this approach is often not feasible for real-world applications.

A second approach involves developing a macro-level model for using OA data for MPT planning. Such a model has recently been developed for strategic training planning. That model, the Training Decisions System (TDS; Mitchell, Vaughan et al., 1992; Vaughan et al., 1989), illustrates how OA might make the step from pure description to explicit prediction of future organizational outcomes under various complex policy scenarios. Such a model would express important macro-level outcome variables (e.g., organizational productivity, mission effectiveness) as functions of important empirically related variables. These include both micro-level variables that are directly manipulated in organizational interventions and more macro-level variables, such as business and economic conditions. This type of model would be very useful for exploring the quantitative relationships among events at various levels of abstraction. The model could be used to determine the maximum impact that micro-level organizational interventions can reasonably be expected to have on macro-level outcome variables, relative to other uncontrolled events.

A model of this type will permit users to estimate impacts on outcome variables of interventions at lower levels of abstraction (e.g., at the individual level) while holding other variables constant (Vaughan & Yadrick, 1992). Such a model can also be used to study the relative sensitivity of outcome variables to the various types of input variables. This sort of sensitivity analysis can

be used to determine which organizational interventions, if any, are likely to have practical value in light of the many other factors that influence outcome variables.

The overall purpose of the TDS is to support strategic MPT planning for specialties (occupations) within the Air Force. The TDS meets this objective by estimating important organizational impacts associated with structuring training for an occupation in various ways, so that trade-offs associated with different approaches to meeting task training requirements (e.g., mixes of classroom, laboratory, and on-the-job training) can be studied. The overall objective in building the TDS model was to take into account the key drivers of training resource requirements and costs, including non-training-related factors.

A TDS model for an organization or occupation requires a great deal of data about the job structure, training structure, and tasks to be modeled. These data come from many different sources. The sources of data include existing data bases (e.g., the occupational survey/CODAP job analysis data base), and related manpower, personnel and training data bases. In addition, much of the data come from SMEs' judgments. As the above discussion suggests, a TDS model for an occupation is built in pieces. Various classes of model parameters are estimated separately, from separate data sources. These classes of parameters are then combined to form a complete TDS model. For example, in the U&TP simulation, jobs and task content, training courses and task content, and transition probabilities must be estimated separately (Mitchell et al., 1993). In many cases, multiple data sources must be used for estimating a particular class of parameter. Furthermore, parameters may not be obtained using strict statistical estimation procedures. One reason for this concerns issues in combining inconsistent data from multiple sources. Another stronger reason concerns the generalizability and application of model results. Historical data often reflect the state of an occupation several years ago. However, the model results are used to describe the current situation and extrapolate to the future. Thus, it is often necessary to adjust historical model parameter estimates to reflect recent and expected changes.

Occupational Analysis-Based Modeling

Several other significant MPT planning areas could benefit greatly from development of complex OA-based organizational models. One example is in the manpower area. The actual manpower required to accomplish work activities (e.g., numbers of task performances or time spent working on tasks) is a function of many variables. Some of these variables, such as task characteristics, job structure, and task times, are clearly OA-related. Others are more closely related to mission requirements under various scenarios and to overall manpower and personnel policies and procedures, such as the occupational structure and classification procedures. Decision-making concerning manpower issues such as occupational structuring and restructuring could benefit greatly from a model that would estimate total costs (e.g., manpower requirements) from OA data and other data under various alternative scenarios (e.g., hypothetical occupational structures).

Much of the discussion thus far has focused on complex organizational outcome modeling. However, there are many areas that would benefit greatly from simpler OA-based modeling.

This was demonstrated by the success of the compensation models and the Ruck et al. (1987) training emphasis research. In training planning, for example, a simple model that distinguishes between formal classroom and OJT for training on a task would be very useful. The model could be viewed as an approximation to the TDS, and could be used in the many circumstances where the time and expense of applying the TDS are not warranted. Similarly, a simple model that identifies those jobs or tasks in different occupations which could be placed in a "common" occupation would be very useful.

A Unified Theory of Work

The discussion above covers a great deal of ground. To a great extent, OA technology in the DoD has been developed in response to specific applied problems and issues in MPT planning and management. This is also true of the future directions for OA proposed above; that is, to a great extent they are motivated by specific applied problems in MPT and in OA practice. As a result, the various directions are not well connected or integrated. In the long run, the DoD needs a truly integrated MPT planning and management system--an "ultimate person-job match system" (Ward et al., 1992). Progress toward this ultimate person-job match system, as well as synergism and focus in progress in the future directions proposed above, requires an integrating framework. We believe that a unified theory of work is needed to provide this framework and to guide and focus OA and related R&D.

What should such a unified theory of work be about? Fundamentally, such a theory should relate task performance to the task and worker variables that cause such performance. For tasks, these will include the variables inherent in such tasks (e.g., task learning difficulty, underlying skills and knowledges required to perform), as well as environmental and organizational structure and climate variables. For workers, these will include variables inherent in people, such as aptitudes, abilities, personality, and previous experience, as well as variables related to a particular organizational environment, such as training. Some variables, such as motivation, will have task, worker, and organizational aspects.

This unified theory of work will connect theories of human traits and states, theories of task and job characteristics, theories of job/task performance, and perhaps theories of organizational behavior. For example, Mitchell and Driskill (1986) have proposed a theory that relates training to task performance, via a series of intervening and exogenous variables. Such a theory could be extended to encompass individual differences among workers and tasks, as well as key organizational and environmental variables.

Developing and validating a unified theory of work is a long-term, basic research effort; however, we believe that such a theory is necessary to long-term progress in OA. We also believe that a number of key components for such a theory exist. For these reasons, we believe that the time is right to focus on developing such a unified theory of work.

Summary

The purpose of this chapter has been to highlight potential future directions in occupational analysis. In an era of declining research and operational resources, it is likely that greater demands will be placed upon the OA process as a means of providing detailed information to meet a multitude of organizational needs. These needs will include not only "traditional" uses of occupational data, such as identifying job requirements and portraying the current status of military occupations, but also more sophisticated uses such as modeling alternative organizational structures, developing prescriptions of future training needs, and quantifying the costs and resource requirements for changes to jobs and occupations.

The research directions and applications proposed and discussed here will provide the necessary foundation upon which new uses of occupational analysis methods and products can be based.

VII. COMMENTS OF DISCUSSANTS

This chapter contains comments made by three of the Symposium's four discussants: J. W. Cunningham, North Carolina State University; Walter E. Driskill, Metrica, Inc.; and James E. Sage, The Ohio State University. Written comments of the other discussant, Walter C. Borman, University of South Florida, were not available at the time of publication of this report.

Discussion: A Nomothetic Approach to Job Analysis

J. W. Cunningham
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In all honesty, I can say I'm very impressed with the work that has been described here. As Jimmy Mitchell already mentioned (in Chapter I), the military services have been among the largest contributors and supporters over the years in advancing systematic occupational analysis. And, of course, the Task Inventory/CODAP method has played the major role in that development. This method has proven to be a very powerful tool and, it's safe to say, is the most widely used of all quantitative job analysis methods. I think the introduction of co-performance task modules, as described earlier, will add considerably to its power.

The efforts reported by Phillippo and Higgs (in Chapter III) and by Fugill, Weissmuller, and Archer (in Chapter IV) have directed much-needed attention to the activities and training of people involved in occupational analysis. And the other presenters (authors) have described innovative methods and procedures that will unquestionably extend the applications of occupational analysis, in both the military and the civilian settings.

Unfortunately, there isn't time to credit or comment in detail on all these important contributions. Instead, I'll take the opportunity to talk briefly about an approach that I think could serve as a useful supplement to the job-task inventory. I've labeled it the "nomothetic" approach to job analysis. Its most notable representative is the Position Analysis Questionnaire (PAQ) developed by Ernest McCormick and his associates at Purdue University under support of the Office of Naval Research (McCormick et al., 1972). A more recent example is the General Work Inventory (GWI) that Rodger Ballentine, William Wimpee, and I have developed and researched in the Air Force setting (Cunningham et al., 1990). See Figure 8 for details on these two approaches.

The nomothetic approach uses descriptors that are applicable to broad ranges of jobs, in comparison to what might be called the "ideographic" approach, which uses descriptors specific to individual jobs or restricted job categories. Some abbreviated examples of nomothetic descriptors are shown in Figure 8. In this connection, McCormick has contrasted worker-

oriented variables, which represent basic human behaviors and requirements, with job-oriented variables, which represent technological content relevant to the purposes and outcomes of work. For example, "Depth Perception" (in the PAQ item examples) could anchor the worker-oriented end of McCormick's continuum, whereas "Electrical/Electronic Information" (in the GWI examples) is clearly job-oriented. Other nomothetic descriptors fall in between these two extremes, and McCormick's distinction is not always so clear-cut. The PAQ was designed to contain mostly worker-oriented items, whereas the GWI contains about equal numbers of both worker- and job-oriented items.

NOMOTHETIC DESCRIPTORS: General descriptors applicable across a broad spectrum of jobs and occupations.

POSITION ANALYSIS QUESTIONNAIRE (PAQ)
(McCormick, Jeanneret, & Mecham)

Abbreviated Item Examples

Written Materials	Quantitative Materials	Visual Displays
Verbal Sources	Depth Perception	Estimating Speed of Moving Objects
Estimating Size	Inspecting	Transcribing
Analyzing Information or Data	Precision Tools/Instruments	Measuring Devices
Stationary Machines/Equipment	Assembling/Disassembling	Hand-Arm Steadiness
Advising	Persuading	Interviewing

GENERAL WORK INVENTORY (GWI)
(Cunningham, Wimpee, & Ballentine)

Abbreviated Item Examples

Night Vision	Tables/Graphs/Charts	Ordinary Speaking
Electrical/Electronic Information	Legal/Contractual Information	Basic Arithmetic
Visualizing Objects	Social Judgment	Coordination and Balance
Small Handtools	Using Office Machinery/Equipment	Maintaining/Repairing/Setting-Up Machines
Supervising	Cooperating	Teaching
Health Treating/Caring		

IDEOGRAPHIC DESCRIPTORS: Specific descriptors applicable to individual jobs or job categories.

JOB-TASK INVENTORY
(Military Services)

CRITICAL INCIDENTS TECHNIQUE
(Flanagan)

Figure 8. Nomothetic and ideographic descriptors.

Examples of more ideographic kinds of descriptors can be found in task-inventory items and in critical-incident statements. In addition to being much more focused or fine-grained than nomothetic descriptors, the ideographic descriptors are almost entirely job-oriented--the task-inventory items probably moreso than the critical-incident descriptions.

As I see it, the nomothetic and ideographic descriptors should be considered complementary in their uses and limitations. The nomothetic variables allow for general description, comparison, and classification of jobs across a broad spectrum, whereas the ideographic descriptors provide more specific and detailed job information that would slip through a nomothetic net. So, I propose a marriage between these two approaches.

Potential uses of nomothetic descriptors are shown in Figure 9.

POTENTIAL USES OF NOMOTHETIC DESCRIPTORS

NUMERICAL OCCUPATIONAL CLASSIFICATION
TASK MODULE CLUSTERING
ESTIMATING JOBS' HUMAN CAPABILITY REQUIREMENTS

Figure 9. Potential uses of nomothetic descriptors.

One potential use of nomothetic descriptors would be in deriving broad numerical occupational classification structures. For example, we've recently had encouraging success in hierarchically clustering Air Force enlisted specialties based on their GWI ratings.

Nomothetic descriptors also might prove useful in rating and clustering co-performance task modules, producing higher-order or meta-modules. Such meta-modules could be interpreted as broad generic tasks which, if translated into descriptors, could be used to profile and compare relatively wide ranges of jobs and occupations. Moreover, it seems to me that the meta-modules, along with their constituent co-performance modules, would provide a reasonable basis for defining generalizable knowledges and skills.

Another application of nomothetic descriptors would be in estimating jobs' general human capability requirements, following McCormick's job component approach. The general approach involves: first, defining a universal set of "job components," or nomothetic descriptors, and then deriving requirement weights for those components on various human capabilities.

Subsequently, capability-requirement estimates can be derived for any job that has been rated on the weighted components. Table 5 depicts the requirement weights for q job components on k defined capabilities, many of which would be represented by tests. There are at least three ways of deriving these weights, and we're currently exploring them with the GWI.

Table 5

Requirement Weights for q Job Components on k Defined Capabilities

	Human Capabilities								
Components	1	2	3	.	.	.	.	.	k
1	W11	W12	W13	.	.	.	.	.	W1k
2	W21	W22	W23	.	.	.	.	.	W2k
3	W31	W32	W33	.	.	.	.	.	W3k
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
q	Wq1	.	.	.	.	.	.	.	Wqk

Figure 10 provides a listing of the kinds of capabilities I think could be accounted for by a comprehensive set of nomothetic descriptors. These include Basic Physical and Psychomotor Abilities, Basic Mental Abilities, General Nontechnological Knowledges and Skills (such as those defined by the SCANS Commission and by Employment and Immigration Canada), and Generalizable Technological Knowledges and Skills (such as the General Vocational Capabilities posited some years ago by Altman and Gagne). Nomothetic descriptors could also be readily linked to work-related interests.

HUMAN CAPABILITIES LINKABLE TO NOMOTHETIC JOB DESCRIPTORS

SENSORY CAPACITIES
(visual, auditory, tactual, etc.)

BASIC PHYSICAL AND PSYCHOMOTOR ABILITIES
(e.g., as defined by Fleishman & Quaintance, 1984)

BASIC MENTAL (COGNITIVE) ABILITIES
(as measured by standardized aptitude tests)

GENERAL NONTECHNOLOGICAL KNOWLEDGES/SKILLS
(generalizable, trainable, and free of occupational content)

Basic Educational Skills, Social Skills, Communication Skills, Etc.
Examples
Fundamental Skills (SCANS Commission)
Generic Skills (Employment & Immigration Canada)
Cross-Functional Skills (U. S. Employment Service)

GENERAL TECHNOLOGICAL KNOWLEDGES/SKILLS
(generalizable, trainable, and explicitly occupational/technological in content)

Content Examples

Common Handtools
Electrical/Electronic Components
Tables/Graphs
Filing
Rules of Effective Service
Computer Usage

Mechanical Principles
Connecting/Fastening Devices
First Aid Practices
Office Routine
Persuasion and Sales Procedures

Measuring Devices
Drawings/Diagrams
Letter/Report Writing
Contracts
Vehicular Operation

CAPABILITIES REPRESENTED BY TASK MODULES AND META-MODULES

OCCUPATIONAL AREA KNOWLEDGES AND SKILLS (META-MODULES)
(generalizable within occupational areas or clusters)

OCCUPATION-SPECIFIC KNOWLEDGES AND SKILLS (TASK CO-PERFORMANCE MODULES)
(applicable within occupations)

Figure 10. Human capabilities linked to nomothetic job descriptors and represented by task modules and meta-modules.

At more focused capability levels, the meta-modules might be considered as representative of generalizable knowledges and skills within defined occupational areas or clusters, and the co-performance task modules could be treated as representative of more specific occupational

proficiencies. The list shown in Figure 10 might be viewed as a hierarchical structure, in which the general capabilities toward the top are assumed prerequisites for the more specific ones below them.

In addition to describing jobs and occupations, a set of nomothetic and module-based descriptors, along with capability-requirement estimates, could provide a framework for profiling the characteristics, training and work experiences of people, thus facilitating the person-job matching process. In this regard, we might envision the development of computerized job and occupational information systems. As shown in Figure 11, these parallel numerical systems would support a number of personnel-related applications.

AREAS OF POTENTIAL APPLICATION

OCCUPATIONAL CLASSIFICATION
TRAINING
TRANSFER
PLACEMENT
RECRUITMENT
CAREER DEVELOPMENT
PERFORMANCE APPRAISAL
HUMAN RESOURCE PLANNING

Figure 11. Potential personnel-related applications.

These potential applications would include, for example, occupational classification, training, transfer, personnel placement, recruitment, career development, performance appraisal, and human resource planning.

Discussion: Some Critical Needs in Military Occupational Analysis

Walter E. Driskill
Metrica, Inc.

After listening to this series of papers, I am struck by several issues, but because of time limitations, I will address only two of them.

First, because I was originally a historian, I believe there is much to gain from understanding the roots of occupational analysis and how the technology has progressed over the past half century. Certainly, the need now is as great, and perhaps greater, for information about jobs in order to deal with practical personnel problems. Now, there are 40 or more occupational or job analysis methodologies that can be located in the literature. Although they approach the study of jobs from different perspectives, they provide information for such personnel functions as selection and classification, training, career development, structuring jobs, etc. Each of these methodologies provides job information using different scales and at varying levels of specificity. As job analysts, we should be aware of the multiple methodologies and the importance of looking at jobs from a variety of perspectives if we are to provide information useful to operators, maintainers, supervisors, and managers. There is no single best method of job analysis. The best approach, in fact, may be a combination of methodologies.

At Metrica, we have employed portions of several methodologies to probe research issues. For example, during the past year, we used elements from Fleishman's Abilities Requirements, elements from Ballentine and Cunningham's General Work Inventory, and the Comprehensive Occupational Data Analysis Programs (CODAP) to study human ability requirements of task-level performance. At the present, we are collecting critical incidents information from pilots who have Desert Storm combat experience. One approach we will apply to understanding these incidents is the use of hierarchical grouping analysis from CODAP, with the ultimate goal of identifying the dimensions of combat pilot performance and the identification of human attributes that contribute to successful performance.

I would urge you to extend your knowledge and application of job analysis methods. Though I know most of you are committed to the task-based approach using CODAP as the analysis tool, please recognize that CODAP can be a very useful analysis tool for other job analysis methods as well--as evidenced by our recent study of human ability requirements. Data collection to support other methods can be readily accomplished in conjunction with the collection of task data.

Second, the remaining papers highlight what in my mind is a serious deficiency that has existed for the past 25-plus years. Simply put, extensive research and development has been directed at expanding and improving the analytic capabilities of CODAP. I acknowledge that these efforts have provided some significant advances. <u>But</u>, research to improve our methods for describing jobs in terms of task requirements has been virtually nonexistent. To my knowledge,

this work has been limited to our work pertaining to methods for developing weapon-system-specific tasks. Although this work was tangential to another research objective, it demonstrated that in the maintenance arena there are data bases from which tasks describing work on any aircraft or missile can be compiled. Software for accessing these data bases and for compiling tasks describing technical maintenance activities is available.

Further, based on our experience in accessing maintenance data bases, I am firmly convinced that other data bases pertaining to non-maintenance occupations exist and could be accessed to develop tentative task statements for most other occupations. The most important advantage of developing such a technology is the extent to which communication with respondents and decision-makers could be immensely improved.

And, it is the improvement of such communication that cries out to be accomplished. Whether we like it or not, as CODAP practitioners we have to recognize that task description leaves a lot to be desired. In our research over the past 4 or 5 years, we have had occasion to experience firsthand the problems of poor task description. We have found, for example, that as many as 35 percent of the respondents to a job inventory misunderstood some of the tasks in the list.

The need for better task lists has existed since the initiation of the Air Force occupational analysis program on July 2, 1967. It is a pity that research in this area, which would cost only a small fraction of that spent on expanding and improving the analytic capabilities of CODAP, has been neither supported nor funded. All of us should recognize that though an improved analytic capability may assist us in analyzing poor data, the best analytic capability cannot overcome the shortcomings and dangers of <u>misinformation</u>.

Discussion: Automated Self-Report Questionnaires--Highlights of a CODAP Pilot Study

James E. Sage
The Ohio State University

Job and occupational analyses are managerial activities performed to gather, analyze, and synthesize data that describe the inter- and intra-relationships of jobs within a particular organization. These data provide a foundation upon which the organization plans and redefines itself. In addition, these data provide the human resource manager and human resource developer with the legal foundations on which to make employee-related decisions. That is, job and occupational analyses are analytical processes that investigate the relationships between the components of jobs and the relationship of the job to the organization. These analytical processes produce outputs, inputs, and throughputs that are used to describe these relationships. The primary, first-level product of these processes is a "descriptive" job description produced from job analysis data.

The job description plays a critical role in detailing employer-employee relationships. It defines the mission; it provides a specification of the expectations the employer has of the employee relative to the services rendered or products produced; and it specifies the essential job performances and required knowledge, skills, and abilities (KSAs).

Because the employer-relationship is governed by a dynamic legal framework, analysts need to be sensitive to developments on the legal front. The legal framework that governs employer-employee relationships is built on Constitutional provisions (First, Fifth, Thirteenth, and Fourteenth Amendments; Civil Rights Acts of 1866, 1870, and 1871); Federal Statutes (e.g., National Labor Relations Act, Civil Rights Act of 1964, Equal Employment Opportunity Act, and Americans with Disabilities Act); Executive Orders such as No. 11141 (1964), No. 11246 (1965), and No. 11478 (1969); Agency Rules and Regulations such as the Uniform Guidelines of Employee Selection (29 CFR 1607) and regulations to implement the Equal Employment Provisions of the Americans with Disabilities Act (PL 101 336, 29 CFR 1630); as well as Case Law. Some of the legal cases which support the need for responsible job analysis and job descriptions are listed in Figure 12.

The military's CODAP system is a job-oriented, inventory-based system that has shared the popularity of the inventory concept with the other inventory-based analysis processes. The utilization of CODAP's multiple-inventory philosophy is very useful when the "whole job" needs to be described. The atCODAP is a separate PC-based system developed to meet the needs of smaller organizations which cannot support mainframe CODAP. The atCODAP system has a companion product called atSURVEY to collect data on background; task performance; essential knowledge, skills, and abilities; essential physical requirements; and essential job functions.

A pilot-test of the atSURVEY system was conducted by this discussant to assess its potential for civilian applications. The test was highly successful and produced job descriptions that address

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Dexler v. Tisch 660 F.Supp 1418 (D. Conn 1987)

Donaldson v. Pillsbury Company, 554 f.2d 825 (8th Cir 1977)

Guardians Asso. of New York City Police Dept., Inc. v. Civil Service Com. f.2d 79,23 FEP. Cas (BNA) 909, 23 FEP Cas Dec. (CCH) P 31154 (2nd Cir. 1980)

Hall v. U.S. Postal Service, 857 f.2d 1073 (6th Cir 1988)

Patterson v. American Tobacco Company, 586 f.2d 300 (4th Cir, 1978)

Watkins v. Scott Paper, 12 FEP 1991 (1976)

Weahkee v. Perry 587 f.2d 1256 (D.C. Div. 1978

Figure 12. Job analysis and job description case law.

the concerns expressed by America's legal framework. The pilot-test also indicated that the following refinements to the automated self-report development process are needed in order to make it more useful to non-military users:

1. r values printed for each inventory;

2. v (validity) values printed for each inventory;

3. hard copy of the automated self-report survey;

4. a histogram of inventory items, to illustrate overlap between job descriptions;

5. a non-military-user-friendly menu system;

6. a non-military-user-friendly operations manual; and

7. a job description generator.

The pilot-test indicated too that the atSURVEY system is extremely versatile and compatible with all of the computer platforms listed in Figure 13.

IBM PS-2 Models 30, 50, and 80

Toshiba 1100 and 1200

Compaq 386

Notebook 486-DX 2 50 MHz

Zenith 286 Portable

Hyundi 286 Turbo

ASC 386 SX

Dell 486 SX notebook

Dell 386 DX

Columbus MicroSystem 486 DX-33

Next

IBM XT and AT

Figure 13. Computer platforms tested.

[**Note:** Additional comments and viewgraphs from Dr. Sage's presentation may be found in the 1993 *Proceedings of the Eighth International Occupational Analysts Workshop* (pp. 85-115). San Antonio, TX: USAF Occupational Measurement Squadron.]

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